ALL-INDIA SURVEY
of
ACHIEVEMENT
in
MATHEMATICS

STATE INSTITUTE OF EDUCATION
Govt. of West Bengal.

NATIONAL COUNCIL OF EDUCATIONAL RESEARCH AND TRAINING

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STATE INSTITUTE OF EDUCATION
Govt of West Bengal.

ALL INDIA SURVEY
OF
ACHIEVEMENT
IN
MATHEMATICS

(Primary Middle and High School)

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FOREWORD

The National Council of Educational Research and Training (NCERT) is concerned primarily with the improvement of standards of school education in the country. In matters of standards there has been in recent years a great concern and there has been a general feeling that our standards are falling. While there may be much truth in it, it is necessary and possible to collect evidence in the matter of standards. Educational decision-making tends to be based on insufficient data and there is particularly a lack of objective evidence. Opinionated approaches in the field of education in our country since independence have not helped in the educational development of the nation. It is, therefore, necessary to make a beginning with a scientific approach to educational decision-making so that the meagre resources of the nation can be optimally utilized. This is particularly true in the matter of standards.

The Education Commission in its report has emphasised the importance of upgrading of teaching of Science and Mathematics at the school level so as to achieve higher standards at the post-graduate stage. The NCERT since the beginning has considered the improvement of Science teaching in schools as one of its major programmes. As a part of this programme the syllabi at all stages of school education have been revised, new textbooks are being written, teachers' guides, work books, laboratory guides, prototype apparatus etc., are being produced with the assistance of the UNESCO and UNICEF. A number of Study Groups have been set up with university professors in the sciences and mathematics to develop independently new materials for science teaching. An integrated four-year course of training science teachers has been going on in the Regional Colleges of Education of the NCERT. While all these attempts were being made, we decided to make a scientific study of the standards of learning in Mathematics at the end of primary, middle and high school education.

In order to collect objective data, achievement tests of mathematics were prepared in all the Indian languages at the three levels *viz.*, primary, middle and high school. For each level, two equivalent forms were developed so that one could be released for general use and the other could be used for purposes of research and further development. With these tools a sample survey was conducted throughout India except Madras and Bihar. In Madras, it could not be done because the State Government did not finally agree to the use of the tests. In Bihar it could not be done because in that state schools had remained closed due to disturbances at the time of survey. In preparing the tests, an attempt has been made to provide achievement data and also to provide information on the weaknesses and strengths in school mathematics. It was a large undertaking. Other than the IEA project, which involved the participation of several nations, no other country has attempted such a large scale study. It involved the help and cooperation of professors, teachers, experts and administrators throughout the country and we are very much grateful to them for the unstinted help and support rendered to us.

In the original proposal the sampling design was somewhat different from what was followed during the course of this study. Even to prepare a sampling frame for the primary and middle schools was a huge task. This was taken up as a separate project in the then Department of Psychological Foundations, but unfortunately the frame was not ready for drawing samples at the time of the survey. The large volume of data collected in the survey could not all be analysed. Only the essential analysis as required by the project proposal was done with the help of computers; and even that had taken a lot of time.

The success of the project is due to the untiring efforts and diligent application of Dr. S.S. Kulkarni, Principal Investigator of the Project and the young and able staff in the project team, who assisted him in all the stages of the work.

Chapters 1 to 7 of the report gives in detail the procedure of the development of the tests, sampling etc. Some methodological and administrative problems are also discussed. Chapters 8 to 12 give test characteristics and findings of the survey in each state and Chapter 13 deals with some aspects of data processing. It is hoped that our teachers and educationists would find this material of considerable interest in the teaching and learning of mathematics in our schools. As the aim of any testing is a feedback for the improvement of teaching and learning, I expect that in the present case also feedback will help the improvement of mathematics teaching. Those who are interested only in the research aspects will find many interesting and challenging methodological problems. It is hoped that some might be interested in using the data in new ways to get answers to some of the psychometric problems, which they may like to raise.

This study shows the possibilities of periodic sample surveys of educational achievement in our schools with a view to improve the standards. If the study stimulates further work in the teaching and learning of mathematics in our schools, our labours would be amply rewarded.

New Delhi
13 *April*, 1968

SHIB K. MITRA
Project Director

ACKNOWLEDGEMENTS

This was a nation-wide project. As such it could be completed only because we received co-operation and help from a large number of persons. The names of these persons may not have been recorded on the official files. But we are certainly grateful to all those who have helped us—teachers of the schools where the Survey was conducted, heads of various organisations like State Departments of Education, State Institutes of Education, University Departments, etc., and our colleagues in the National Institute of Education. Sometimes the same and sometimes different persons have helped in the different phases of the project. We owe our thanks to them. The names of these persons are given in Appendices 1.1 to 1.6.

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CONTENTS

Foreword iii

Acknowledgement v

1. Project Objectives and Design of the Project 1
1.1 Mathematics Achievement Survey 1
1.2 General Design of the Survey 3

2. Review of Literature 6
2.1 Studies in India in the Content of Assessing Mathematics Achievement 6
2.2 Studies on Methods of Evaluation 7
2.3 Studies Abroad 7
2.4 Mathematics Achievement Survey in Japan 12
2.5 International Study of Achievement in Mathematics 14

3. Preparing Tables of Specification 16
3.1 Analysis of the Syllabi 16
3.2 Classification of Objectives 18
3.3 Analysis of Content Areas 18
3.4 Working Papers for the National Advisory Committee 18

4. Item Writing 22
4.1 Item Writers' Workshop 22
4.2 Error Analysis 22
4.3 Instructions for Item Writers 24
4.4 Screening of Items 24
4.5 Item Types 25

5. Try-out 27
5.1 Preparation of the Forms for Try-out 27
5.2 Printing of Tests 28
5.3 Translation in Different Languages 29
5.4 Directions and Practice Item Booklet 29
5.5 Testing Procedure 31
5.6 Sampling Design for the Try-out 33

6. Item Analysis and Preparing Two Equivalent Forms 35
6.1 Item Analysis 35
6.2 Selection of Items 38

6.3 Preparation of Parallel Forms 39
6.4 Separate Answersheets for High School Level 41
6.5 Printing of Final Forms 45

7. SAMPLING 46
7.1 Sample Surveys 46
7.2 Sampling Unit 46
7.3 Sources of Information for Preparing the Frame of Schools 47
7.4 Multi-stage Sampling Procedure 47
7.5 Allocation of Schools 50
7.6 Biases in Sampling of Schools 55
7.7 Test Administration Procedure 56
7.8 Limitations in Interpreting the Findings 56

8. TEST CHARACTERISTICS 65
8.1 Organisation of the Tests 65
8.2 Validity of the Tests 65
8.3 Reliability of the Tests 66
8.4 Item Analysis 71
8.5 Norms 74
8.6 Testing Procedure 74

9. MATHEMATICS ACHIEVEMENT—GEOGRAPHICAL VARIABLES 76
9.1 States—Mathematics Achievement 76
9.2 Regions—Mathematics Achievement 81
9.3 Sector Variable—Mathematics Achievement 98

10. MATHEMATICS ACHIEVEMENT—SCHOOL VARIABLES (*Management, Higher Mathematics and Streams*) 106
10.1 Management 106
10.2 Higher/Lower Mathematics 109
10.3 Streams 110

11. MATHEMATICS ACHIEVEMENT—STUDENT VARIABLES (*Sex and Age*) 113
11.1 Mathematics Achievement—Sex Variables 113
11.2 Mathematics Achievement—Age 119

12. MATHEMATICS ACHIEVEMENT AS RELATED TO ATTITUDE AND OTHER STUDENT/PARENT VARIABLES 128
12.1 Student Questionnaire 128
12.2 Parental Variables 130
12.3 Student Variables—Expectations, Aspirations etc. 136
12.4 Student Variables—Attitudes etc. 142
12.5 Conclusions 150

13. DATA PROCESSING 151
13.1 Introduction 151
13.2 Test Format 151
13.3 Data Processing—Try-out stage 151
13.4 Data Processing—Final stage 152
13.5 Data Bank 153

APPENDICES

Chapter 1. 155
1.1 Participants of National Advisory Committee—First meeting 155
1.2 Participants of National Advisory Committee—Second meeting 167
1.3 Organizations and individuals who helped in MAS Survey 160
1.4 Participants of item writers' workshop 163
1.5 Translators and evaluators 165
1.6 Co-ordinators for printing of tests 168

Chapter 3. 169
3.1 Consolidated statement of the common and less common topics at Primary, Middle and High school levels 169
3.2 Specimen of the analysis for the topic on decimals at Middle level. 174

Chapter 4. 176
4.1 Specimen of the tests used in the try-out test 176
4.2 Suggestions for writing multiple-choice test items 177
4.2a Illustrative items circulated to item writers 182

Chapter 5. 183
5.1 Note to translators 183
5.2 Note to evaluators 186
5.3 Note to invigilators and supervisors 189
5.4 Specimen of glossary (at High school level) 192
5.5 Instructions to invigilators to fill in item evaluation forms 195

Chapter 7. 196
7.1 Instructions to supervisors and invigilators—Primary and Middle levels 196
7.1a Instructions to supervisors and invigilators—High school level 199

Chapter 8. 203

8.1 Item statistics for three states at try-out and final survey—Primary level 203

8.2 Item statistics for three states at try-out and final survey—Middle level 206

8.3 Item statistics for three states at try-out and final survey—High school level 210

8.4 Scoring keys for Primary level tests 215

8.5 Scoring keys for Middle level tests 217

8.6 Scoring keys for High school level tests 219

Chapter 12. 221

12.1 Categorisation of occupations 221

Chapter 13. 223

13.1 Card design at Primary level 223

13.2 Card design at Middle level 224

13.3 Card design at High school level 225

References 226

TABLES

Chapter 1.

1.1 States/Groups which participated in the try-out and final Survey. 4

Chapter 2.

2.1 Number of published mathematics tests available as of 1960 8
2.2 Test characteristics of STEP series 10
2.3 Test characteristics of IOWA tests 11

Chapter 3.

3.1 Number of items in different cells of table of specifications for Primary level tests 19
3.2 Number of items in different cells of table of specifications for Middle level tests 20
3.3 Number of items in different cells of table of specifications for High School level tests 21

Chapter 4.

4.1 Specimen of the proforma used in error-analysis —Middle level 23
4.2 Allocation of items to different item formats —Primary level 24
4.3 Allocations of items to different item formats —Middle level 25
4.4 Allocations of items to different item formats —High School level 26

Chapter 5.

5.1 Effect of practice items on mathematics achievement 30
5.2 Item evaluation form 32

Chapter 6.

6.1 Item analysis worksheet 36
6.2 Item analysis worksheet for consolidating item statistics of different states 37
6.3 Distribution of item statistics—Primary level 40
6.4 Distribution of item statistics—Middle level 42
6.5 Distribution of item statistics—High school level

Figure 6.1 Graph showing percentage of items in different objectives of the parallel forms of the tests. 44

Chapter 7.

7.1 Stratification of states into regions 48
7.2 Number of schools allotted, selected and responded in different states 50
7.3 Proportion of schools allotted to different regions within states 52
7.4 Response position in big cities 53
7.5 Response position of schools in different states at the three levels 58
7.6 States where sub-sampling of answer scripts was done 62
7.7 Means calculated on total data and sampled data from Kerala schools 63

Chapter 8.

8.1 Test characteristics—Primary level 67
8.2 Test characteristics—Middle level 68
8.3 Test characteristics—High School level 69
8.4 Parallel form reliability coefficients at the three levels 70
8.5 Intra-class correlation coefficients 71
8.6 Diagnostic information for the topic fractions and decimals 72

Chapter 9.

9.1 Performance of states at different levels 77
9.2 Average difficulty values of different topics —Primary level 79
9.3 Average difficulty values of different topics— Middle level 78
9.4 Average difficulty values of different topics— High School level 81
9.5 Average difficulty values of different objectives —Primary level 80
9.6 Average difficulty values of different objectives —Middle level 83
9.7 Average difficulty values of different objectives —High School level 84
9.8 Average difficulty values of topics of the Primary level tests for VI, VII & VIII grade students 85
9.9 Average difficulty values of objectives of the Primary level tests for VI, VII & VIII grade students 86
9.10 Average difficulty values of topics of the Middle level tests for IX, X & XI grade students 86
9.11 Average difficulty values of objectives of the Middle level tests for IX, X & XI grade students 87

9.12 Regional differences in mathematics achievement —Andhra Pradesh 89
9.13 Regional differences in mathematics achievement —Gujarat 89
9.14 Regional differences in mathematics achievement —Kerala 91
9.15 Regional diffierences in mathematics achievement —Madhya Pradesh 91
9.16 Regional differences in mathematics achievement —Maharashtra 93
9.17 Regional differences in mathematics achievement —Mysore 93
9.18 Regional differences in mathematics achievement —Orissa 94
9.19 Regional differences in mathematics achievement —Rajasthan 94
9.20 Regional differences in mathematics achievement —Uttar Pradesh 96
9.21 Language/regional differences in mathematics —achievement—Jammu & Kashmir 95
9.22 Language differences in mathematics achievement —Central Schools 97
9.23 Urban/rural differences in mathematics achievement —in States 98
9.24 Trends of urban/rural differences in mathematics achievement—in regions 102

Chapter 10.

10.1 Mathematics achievement of students in government and non-government schools 107
10.2 Mathematics achievement of students taking up higher mathematics and lower mathematics 111
10.3 Mathematics achievement of students opting for Science and Humanities streams 112

Chapter 11.

11.1 Mathematics achievement of boys and girls in states 114
11.2 Trends of differences in mathematics achievement of boys and girls in regions within states 117
11.3 Age groups at different levels 120
11.4 Modal age and grades to which the tests were administered in different states 120
11.5 Mathematics achievement of different age groups 122

Chapter 12.

12.1	Sample chosen for attitude study	129
12.2	Mathematics achievement and socio-economic status	130
12.3	Mathematics achievement—father's occupation	132
12.4	Mathematics achievement—father's level of occupation	131
12.5	Mathematics achievement—father's education	134
12.6	Mathematics achievement—mother's education	134
12.7	Mathematics achievement—school performance	137
12.8	Expectations and aspirations of the students	136
12.9		133
12.10		140
12.11	Availability of resources and facilities	140
12.12		141
12.13	Extra help or coaching in learning mathematics	142
12.14		141
12.15	Attitude towards mathematics as a process	143
12.16		143
12.17		143
12.18		144
12.19		144
12.20		145
12.21	Attitude towards place of mathematics in society	145
12.22		145
12.23		146
12.24	School learning	146
12.25		147
12.26		147
12.27		147
12.28		149
12.29	Attitude towards man and his environment	149
12.30		149
12.31		

CHAPTER I

PROJECT OBJECTIVES AND DESIGN

1.1 Mathematics Achievement Survey

1.11 *Why Mathematics Achievement Survey*—An educational planner at state or national level would like to know the existing level of achievement, on the basis of which information alone he can plan for the future. In the context of education he would like to know answers to questions like which geographical regions and/or school systems are weak in what respect? Which educational objectives are fulfilled and to what extent and so on. Surveys of the existing strengths and weaknesses in the dimensions of content and objectives tell us where we are to put the available resources for remedial measures so as to get optimal results. Such surveys also can identify school systems and the factors operating in them which results in better performance.

The Education Commission appointed by the Government of India which submitted its report in June 1966 has come out strongly in favour of such surveys. The commission also pointed out another important reason for conducting such surveys. They maintained that the influence of external examination has to be minimised and teachers should be encouraged to play an important role in evaluation of students' performance by emphasising the practice of internal assessment. But the internal assessment system leaves one important gap. The educational planner and administrator at the national or state level must have a picture of the achievement in their respective region, so that schemes could be formulated for improving the curriculum, teaching methods and for provision of various facilities that have relation with educational performance. For this purpose, to supplement the internal assessment system, surveys with a common tool are recommended by the Commission.

Such surveys also help classroom teachers. The data collected in such surveys would indicate to teachers where their students stand in relation to the general student population. A standardised achievement test prepared in such a survey would enable teachers and school officials to become acquainted with the educational accomplishments and abilities of each pupil in order that instruction and guidance may be better adapted to his/her individual needs, interests and abilities. The survey tests as distinguished from the usual essay type public examinations would also provide more objective and dependable data to help educational authorities identify those areas of the instructional programme which need greater emphasis and/or change.

1.12 *The Specific Objectives of the Mathematics Achievement Survey*—Keeping in mind the uses of the surveys mentioned above the Mathematics Achievement Survey was planned. The Ministry of Education under contract with the office of education with the U.S.A. government approved this project and asked the NCERT to conduct it. The memorandum of the contract specified the objectives in the following manner:

"Developing an understanding of mathematical concepts and the ability to think quantitatively should be among the important goals of mathematics teaching in this age of technology. Policy decisions have been taken in India to revise and to eliminate dead topics and to bring modern concepts within the reach of school leavers. However, basic information which should guide the planners and curriculum makers in this task is still lacking in India. For example, the level of competence in mathematics reached by pupils at the primary, middle and secondary stages has never beendetermined with the result that past attempts at improvement of curriculum did not meet with success. The cautious approach "not to make it too heavy" for the pupil left the present curriculum without any substantial change or improvement. Therefore, a survey of achievement in mathematics will be conducted at three levels of schools education viz; (1) end of primary school or grade V, (2) end of middle school or grade VIII (3) end of secondary school. The specific objectives of the survey will be:

(a) To develop objective tests of mathematics (STEP type) in the major Indian languages at three levels, *viz.*, (1) end of primary school (2) end of middle school and (3) end of secondary school.

(b) To conduct a sample survey on all-India basis of the achievement in mathematics at the three specified levels."

1.13 *The Nature of the Survey Tool*—In India till 1963 no nation-wide survey of achievement in mathematics had been conducted and hence new survey tests in mathematics were to be prepared. There were two possible approaches in preparing such tests. In terms used by Glaser (1963) these approaches could be described as constructing (a) criterion-referenced tests and (b) norm-referenced tests. Ebel (1962) also distinguishes the content standard test from the usual standardised tests which are used more for ranking purposes. The criterion-referenced tests are prepared to assess specified criterion behaviour—the educational goals expected to be achieved by the students. An item in such a test is not thrown out only because it is not discriminating among students due to its high difficulty value. If an item is reflecting a criterion and even if it is found in item analysis that the item is proving to be very difficult for the group, the item will be retained so that the data collected in the survey would indicate the weakness in that area. As distinguished from such criterion-referenced tests the norm-referenced test at the item selection stage gives more weightage to item statistics, the discrimination and average difficulty values. It was hence decided that for the purposes of this survey we should develop criterion-referenced tests and adopt an item analysis procedure which is suitable for constructing such tests.

The criterion-referenced test however should not be confused with specific course content oriented test. The latter type of tests are usually prepared by class teachers in order to assess whether students have mastered the specific topics taught to them in a given period(s). The tests to be used in the survey should assess the broad objectives, basic concepts and skills which are not specific to certain given textbooks or syllabi of a few states. The survey test, it was decided, should be hence more on the lines of the achievement test batteries like the Sequential Tests of Educational Progress prepared by the Educational Testing Service (Princeton) or Iowa Test of Educational Development (prepared by State University of Iowa). This was necessary especially in the Indian context where the different states prescribed different textbooks and different classrooms might be using different teaching methods. Hence it was decided to construct tests that are comprehensive enough to include all the important educational outcomes as agreed upon by the experts in the field of Mathematics education and not biased towards a particular text or teaching method.

1.2 General Design of the Project

1.21 *National Advisory Committee*—A National Advisory Committee was formed to help the project staff to realise the above mentioned objectives. The Committee consisted of the nominees of different State Governments, mathematicians from Universities, Indian Institutes of Technology and such other organisations. (The list of the members is given in Appendix 1.1)

1.22 *Decisions of the National Advisory Committee*—This committee met in Poona in January, 1964. They took the following decisions regarding the nature and format of the tests:

"(i) There should be different tests at different educational levels that is to say there should be separate tests for primary, middle and high school levels respectively.

(ii) The primary level test should refer to the curriculum considered desirable for III, IV and V grades. The middle level test should reflect the curriculum considered to be desirable for the VI, VII and VIII grades. The high school level test should reflect the curriculum considered to be desirable for the IX and X grades (Matriculation stage).

(iii) Within the limits of appropriate complexity, the tests should assess aspects of some of the same understandings and skills at all levels.

(iv) Each test should include a variety of realistic problem situations requiring students to apply their knowledge and skills.

(v) The tests should be long enough to provide reliable measures of students' performance.

(vi) Two equivalent forms should be provided at each level.

(vii) The tests should primarily be a measure of power rather than a measure of speed.

(viii) The tests should be objective type and objective based."

Table 1.1 presents the states in which the survey was conducted at the try out and final stages.

TABLE 1.1

States/Groups which Participated in Try-out and Final Survey

S.No.	*State/Group*	*Level* P	M	H	*Language(s)*
1.	Andhra Pradesh	±	±	±	Telugu, Urdu
2.	Assam	+	±	+	Assamese
3.	Bihar	—	—	—	Hindi
4.	Delhi	±	±	+	Hindi & Urdu
5.	Gujarat	±	±	±	Gujarati
6.	Jammu & Kashmir	±	±	±	Urdu, Hindi & English
7.	Kerala	±	+	+	Malayalam & English
8.	Madhya Pradesh	±	±	±	Hindi
9.	Maharashtra	±	±	±	Marathi
10.	Madras	—	—	—	Tamil
11.	Mysroe	±	±	±	Kannad
12.	Orissa	±	±	+	Oriya
13.	Punjab	±	±	±	Punjabi
14.	Haryana	±	±	±	Hindi
15.	Rajasthan	±	±	±	Hindi
16.	Uttar Pradesh	±	±	±	Hindi
17.	West Bengal	±	±	+	Bengali
Special Categories					
18.	Central Schools	±	±	±	English & Hindi
19.	Public School	±	±	±	English

± Denote that both the try-out and final survey were conducted

+ Only final survey was conducted.

— Only try-out was conducted.

1.23 *Organization of the Survey and this Monograph*—All the strategies of the project were designed to fulfil the above mentioned recommendations of the National Advisory Committee—the various steps taken in conducting this survey and the findings based on the data collected.

In Chapter II the various studies relevant to this survey conducted in India and abroad are described. Some test characteristics of the STEP and ITED tests are given in detail so that a reader may compare the characteristics of the tests prepared for this survey with them. Some relevant findings of the International Study of Achievement in Mathematics are also reported which a reader may keep in mind while interpreting the findings of the Indian study.

Chapter III describes in detail how the table of specifications—objectives and content for the tests were determined after studying the syllabi of all the States in India.

Chapter IV describes the procedure of item writing.

Chapter V describes the process of preparing regional language formats of the tests and trying them out in the various centres of this country.

Chapter VI describes the item analysis procedures adopted and the construction of two equivalent forms at each level.

Chapter VII describes the sampling procedure and the various difficulties that were to be faced in drawing a representative sample and the effect of non-response error.

Chapter VIII describes the test characteristics—the validity, reliability—and also the test administration procedure.

Chapter IX gives the details regarding the achievement in relation to the variables of State, region and sector.

Chapter X describes the relation between achievement and school variables like management, streams and higher and lower mathematics.

Chapter XI discusses the role of variables like sex and age in the context of students' achievement.

Chapter XII describes the findings regarding a sub-sample study on attitudes limited to the high school level only.

The last chapter—XIII—gives some of the important details of the data processing and procedures used in this study and about the Data Bank available for the researchers to conduct further studies in this area.

CHAPTER II

REVIEW OF LITERATURE

2.1 Studies in India Assessing Mathematics Achievement

In India no nation-wide survey of mathematics achievement was conducted prior to 1963 nor was there a tool which could be utilized for such a survey. But this is not to say that no mathematics tests were prepared during this period. Many M.Ed. and Ph.D. students in education take up test construction as their main subject for their research. Nearly 45% of the achievement tests prepared by various research workers are in the field of mathematics. An extensive survey of these tests has been published by Patel (1964). Most of these tests have not been published due to lack of resources. However, none of these tools could be used for any large scale survey due to many limitations some of which may be summarized as follows:

(*a*) None of these tests referred to above have been prepared in consultation with mathematicians and educators from all over India. In other words these tests do not necessarily represent what is considered to be desirable by experts from all over India.

(*b*) None of these studies have provided tests which could be called sequential tests, that is to say no one battery of tests aims to assess the mathematics education at different levels of school education. Different tests constructed separately by test constructors are there. But this has left many important gaps as regards the coverage of the entire spectrum of the content and objectives in mathematics education.

(*c*) Most of the work on tests done so far suffers also from the limitations of the samples on which they were standardized. As noted above, most of these attempts are by M.Ed. or Ph.D. candidates and hence they were not adequately supported financially for inclusion of large samples. The norm data provided by these tests hence are very restricted. Of course, there are some notable exceptions to this. For example, Agashe (1944), Chikermane (1942) Dave (1958) have taken sizable samples from the geographical areas for which the tests were prepared. These areas generally included one part or region of a State but even these studies could not involve an adequately representative sample of the whole State.

2.2 Studies on Methods of Evaluation

Some studies have been conducted in order to study the efficiency of the methods of evaluating pupil-achievement in mathematics, especially in the context of the controversy of the new type and traditional type of examinations. Rangaswamy (1950) and Jacob (1952) have conducted certain studies. One very exhaustive and penetrating study into the efficiency of the examination in Mathematics at the secondary level is conducted by Gayen and others (1961). These investigators analysed the scores obtained by students (10% stratified sample) in Mathematics in the school final examination in West Bengal in the year 1952. The discriminating power, difficulty value and such other characteristics of the questions were studied. The question papers were of essay type or free-response type. They found that the paper could be answered in 256 different ways. The examination did not measure mathematical ability so much as it did ordinary mechanical drilling. Some of the questions were such that even a seventh or eighth class student could get pass marks. A large percentage of passes were due to these easy items, and many of the questions discriminated at a very low level. The paper had choices of unequal difficulty. Its reliability co-efficient was .63 These findings throw valuable light on the manner in which examinations are conducted. Relatively less exhaustive studies on the analysis of answer scripts have been also made by the Bihar Examination Research Bureau and by the Central Examination Unit of N.C.E.R.T. and other Boards of Secondary Education.

Agarwal (1964) in one of his unpublished studies analysed question papers for 4 years set in the mathematics subject of the Higher Secondary Examination of Punjab University. His findings were that the maximum weightage in these papers goes to the objectives of skill and knowledge. The objective of higher cognitive abilities like interpretation of data, analysis, synthesis, etc., are conspicuously absent.

2.3 Studies Abroad

In the developed countries like United States and Great Britain, there are many different kinds of mathematics tests. Myers (1961) presented the following data regarding the types of mathematics tests available in U.S.A.

2.31 *Mathematics Tests in the U.S.A.*

As there are many good published reviews of these tests and the researches involving them, no attempt is made here to do so. An exhaustive bibliography of such studies is given in the 26th Year Book of the National Council of Teachers of Mathematics. What was particularly of importance to us in the project of Mathematics Achievement Survey was the new trend in developing tests on the sequential model as represented by the Sequential Tests of Educational Progress (STEP) constructed by the Educational Testing Service. As noted in Chapter I, the National Committee

TABLE 2.1

Number of Published Mathematics Tests Available in the United States as of January, 1960

Subject	*Purpose*			
	SURVEY	DIAGNOSTIC	PROGNOSTIC	TOTAL
Arithmetic	37	10	2	49
Algebra	20	1	6	27
Geometry	18	1	3	22
Trignometry	3	0	0	3
General Achievement	8	0	0	8
Total				109

Source: *Evaluation in Mathematics*, National Council of Teachers of Mathematics, 26th Yearbook, Washington, D.C., 1961, p. 95

had decided to develop the tests on this sequential model. It would be, hence, appropriate to give some detais here about the mathematics tests in the battery of the STEP series.

2.32 *Sequential Tests of Educational Progress*

2.321 STRUCTURE—The sequential tests of educational progress (STEP) are a series of achievement tests in different subject matter areas. They measure critical skills in application of learning in 7 major fields of school and college instruction. They measure these skills in a continuous way from grade-IV of elementary school through the sophomore year of college. The STEP series make possible a testing programme aimed at the central goal of most teachers *i.e.*, ability of students to use what they have learnt in the classroom. The STEP series provides tests for Essay Writing, Listening Comprehension, Reading Comprehension, Writing, Science, Mathematics and Social Studies. These tests are in a single scale from grade-IV through the sophomore year of college. Each of the tests, except the one on essay writing, has 70 minutes of testing time broken into two sessions of 35 minutes each. Items in each test range from 50 to 80, except again for the essay writing tests. There are 2 equivalent forms of every test at every level in each field. There are 4 levels of these tests designed to be appropriate in difficulty for most students in the classes mentioned below:

Level IV	Grades IV to VI
Level III	Grades VII to IX
Level II	Grades X to XII
Level I	Freshman and sophomore years of college.

2.322 OBJECTIVES—The objectives of the Mathematics Tests in the STEP series may be summarized as follows:

"The traditional organization of mathematics has been largely compartmentalized in the subjects of arithmetic, algebra, geometry, and trigonometry. STEP departs from this organization through use of a vertical analysis of mathematical concepts through various educational levels.

"The mathematics committee, after considerable study, arrived at a list of important concepts. It should be emphasized that these are not mutually exclusive and that a single test question often fits into several categories with different weighting. The STEP tests are constructed to assess competence in skills which are essential in the recognition and application of these concepts."

2.323 CHARACTERISTICS—The tests are designed to provide an instrument for the overall evaluation of an individual or a class with respect to achievement in the broad mathematical objectives of general education. Therefore content is not intended to be specific to one course or to one set of courses.

The concepts accepted by the STEP committee were employed as a guide for the writing of test questions and the construction of test batteries. Although more than one concept often is involved in a single question, it was generally possible to identify the primary concept tested. Many, but not all of the concepts are tested at each educational level.

A series of four to six questions involving various concepts are clustered around situations that are interesting and meaningful at the level tested. These situations represent the kind of experiences in which mathematics are generally applied.

Since it is not possible to pin point the specific grade at which a concept should be mastered, each level of STEP is designed for a range of three grades. At any one grade the appropriate STEP tests will contain questions which are too easy for some students and too hard for others. For some slow or fast groups, the first form tried might not have appropriate difficulty for the group. In this case a shift to a harder or easier level should be made."

2.324 VALIDITY AND RELIABILITY—The validity of the STEP instrument is established to begin with in terms of content validity. It was sought by asking groups of successful teachers, from all levels and many places, to sit down together and list the kinds of learning they could agree were central and continuous in their fields, then to devise test situations that would call forth those kinds of learning. The Technical Report (1957) published along with the test reports the correlations of these tests with the school and college aptitude tests. These correlations range from .60 to .86.

The Technical Report provides the reliabilities in the sense of internal consistency as measured by KR-20. These reliabilities for the mathematics test for Form A are as follows:

TABLE 2.2

Test characterstics for STEP series

Mathematics	*Number of Items*	*Total group*			*100 case sample*	*Reli- ability*	S.E. *of Meas.*
		N	*Mean*	*S.D.*	*Mean*		
Form IA, Grade 13	50	102	21.45	7.59	21.25	.83	3.15
Form 2A Grade 11	50	485	21.96	7.84	21.40	.84	3.12
Form 3A Grade 8	50	447	21.05	7.41	23.05	.83	3.08
Form 4A Grade 5	50	253	22.26	9.02	24.30	.89	3.05

Source: Technical Report for Sequential Tests of Educational Progress, Educational Testing Service, Co-operative Test Division, Princeton 1957, page 10)

The Technical Report does not provide the information on the equivalent form reliability. It, however, provides a table of converted scores equivalent to selected raw scores on these tests. It maintains that the forms of the same level are generally quite similar in difficulty. But no specific data are provided in the Report.

2.33 *IOWA Tests of Basic Skills*

2.331 OBJECTIVES—The IOWA Tests of Basic Skills constructed under the direction of E.F. Lindquist (1956) are also developed on a sequential model. The major purposes of the tests are stated as follows:

(*i*) "To enable teachers and school officials to become more quickly and dependably acquainted with the educational accomplishments and abilities of each pupil in order that instruction and guidance may be better adapted to his individual needs, interests and abilities".

(*ii*) "To supply the teacher counsellor, pupil and parents with important information needed for effective educational guidance."

(*iii*) "To provide the school officials with an objective and dependable basis for the evaluation of schools and class achievement. The test results will help the administrator and supervisor identify those areas of the instructional programme, most in need of greater emphasis, of increased supervisory "drive" or of curriculum reorganisation. Furthermore the highly specific and meaningful definitions of educational objectives contained in the test exercise can do much to clarify the thinking of supervisors and teachers concerning these objectives."

For all these purposes measures of growth as well as of status are highly desirable. These tests hence are developed into 5 major areas: vocabulary, reading, language, work study and arithmetic. In the area of arithmetic separate sub-tests are provided for arithmetic concepts and problem solving.

The important feature of the IOWA Tests of Basic Skills which has a bearing on the Mathematics Achievement Survey Tests is that the IOWA tests provide separate tests for each of the grades III to VIII. No two successive grades take exactly the same test. Like the authors of STEP Tests the authors of IOWA Tests believe that measures of the basic intellectual skills are far more valuable for use in the improvement and individualization of instruction and in educational guidance than are measures of the acquisition of specific information in special subjects. Another reason for such a battery according to them, is that the great heterogeneity or school to school variability in curriculum organization and content makes it impossible to supply tests in these special subjects that are well adapted to most local situations.

2.332 VALIDITY AND RELIABILITY—Like the STEP test, the validity of the IOWA test is also in terms of content validity. The reliabilities of the arithmetic test computed by the split-half procedure are as follows:

TABLE 2.3

Test Characteristics of IOWA Tests

Grade	*Test*	*Standard Deviation*		*Standard Error of Measurement*		*Reliability Co-efficient*
		Raw Score Units	*Grade Equivalent Units*	*Raw Score Units*	*Grade Equivalent Units*	
3.	Arithmetic Concepts	5.99	8.93	2.34	3.43	.85
	Problem Solving	4.70	6.66	2.16	3.06	.79
	Arithmetic Total	5.00	7.14	1.65	2.36	.89
4.	Arithmetic Concepts	6.94	9.22	2.71	3.60	.85
	Problem Solving	4.97	7.74	2.19	3.41	.81
	Arithmetic Total	5.37	7.93	1.72	2.54	.90
5.	Arithmetic Concepts	6.68	3.58	2.31	3.60	.82
	Problem Solving	4.86	3.75	2.33	4.20	.77
	Arithmetic Total	5.40	7.89	1.78	2.60	.98
6.	Arithmetic Concepts	7.51	3.84	3.00	3.54	.84
	Problem Solving	5.77	9.89	2.42	4.15	.82
	Arithmetic Total	6.07	8.59	1.94	2.75	.90
7.	Arithmetic Concepts	7.26	10.02	3.05	4.21	.82
	Problem Solving	4.69	9.82	2.44	5.11	.73
	Arithmetic Total	5.43	9.05	1.57	2.90	.90
8.	Arithmetic Concepts	7.54	11.25	2.94	4.39	.85
	Problem Solving	4.76	11.79	2.43	6.01	.74
	Arithmetic Total	5.64	10.45	1.80	3.34	.90

Sources: *Manual of IOWA Tests of Basic Skills*, Houghton Mifflin Company, Boston, 1956, Table 7, pp. 73-75.

The IOWA Tests of Educational Development (1963) for grades 9 to 12 are also based on the same model as IOWA Tests of Basic Skills (Grades 1 to 8). ITED have two alternate forms X and Y. The reliabilities quoted for the full length version (53 items) of the test on ability to do quantitative thinking are as follows:

TABLE 2.4

Split-half Reliability Coefficients, Full Length Version, Forms X-4 and Y-4

(1960 Study)

Test	*Grade* 9		*Grade* 10		*Grade* 11		*Grade* 12	
	Relia-bility	*S.E. of Meas.*	*Relia-bility*	*S.E. of Meas.*	*Relia-bility*	*S.E. of Meas.*	*Relia-bility*	*S.E. of Meas.*
Form X-4	.82	2.22	.89	2.04	.88	2.13	.91	1.98
Form Y-4	.82	2.27	.87	2.11	.89	2.12	.98	2.18

Sources: *ITED Manual*, Tables 6 & 7, p. 23.

2.4 Mathematics Achievement Survey in Japan

The tests like the STEP or ITED could be used for a nation-wide survey. But no such survey was undertaken in the U.S.A.. by any national agency. A nation wide survey was however conducted in Japan. Although even this survey does not have all the complexities which the project in India has to face, there are quite a few similarities in the purposes and structures in the Japanese survey and Indian survey of Achievement in Mathematics.

2.41 *Purpose*: The Japanese survey (1958) conducted on a nation-wide scale, with school children of elementary, lower and upper secondary schools, had the aim of determining pupils' scholastic achievement in national language and mathematics in order to prepare basic data for teaching, guidance and the adjustment and development of general educational conditions. Like the Indian project the Japanese survey was an attempt to test scholastic achievement in mathematics (in addition to other fields). It also attempted to clarify differences in achievement which are produced by different educational conditions like school size, community type, etc., etc. The basic policy in preparing its questions for the survey tool was described as follows:

General Aim of Question Construction:

(*a*) The questions must be those which will clarify the extent of progress in school achievement towards educational objectives on a nation-wide scale.

(*b*) The questions must provide data which can be made available for comparisons with data from a similar test which will be given several years later.

The Scope of the Questions:

(*a*) Questions should be constructed so as to include as many sub-areas as possible.

(*b*) The specification of these sub-areas should be made in such a way that they may be compared with sub-areas used in future testing.

Level of the Questions:

The general standards for the level of the questions were set as follows:

(*a*) The level of the questions should be fixed according to the standard set forth in the courses of study. The questions should be either at or below the grade level involved.

(*b*) Questions that may be considered too difficult need not be excluded if they have properiety.

(*c*) In preparing a question for the secondary schools pupils, it must be borne in mind that the subjects pursued by individuals in the field of Mathematics, vary quite a bit.

(d) Considering the fact that the administration of this test would fall in September, questions should be prepared so as to be relevant to the progress which participants will presumably have made as of this month.

2.42 *Sample of Pupils and Schools*: The sampling procedure used in this survey may be described as area wise random sampling. Four per cent of schools at the elementary and lower secondary level of education in Japan were selected from each prefecture, according to their size—size being fixed on the basis of pupil enrolment in the uppermost grade. As regards the high school level 30% of the total number of courses offered were sampled—including both full-time and part-time courses throughout Japan. These 20% of the courses were sampled by prefecture distinguishing between full-time and part-time by respective courses and also by size of courses. All the pupils in the grades/courses in the selected schools were administered the test. The testing was conducted simultaneously in one day throughout the country.

The survey report does not mention the test characteristics like the validity and reliability. But it describes in detail the test results in terms of averages obtained by various sub-groups and relates the achievement to the variables of school conditions like size of school, etc., etc. As these findings do not have a direct bearing on the findings in the Mathematics Achievement Survey Project, they are not described here in detail.

2.5 International Study of Achievement in Mathematics

At the time of surveying mathematics achievement in India, International Study of Achievement in Mathematics was undertaken more or less simultaneously under the auspices of the UNESCO and the council of the International Project for the Evaluation of Educational Achievement (IEA). The following countries participated in this international venture: Australia, Belgium, England, Finland, France, Germany, Israel, Japan Netherlands, Scotland, Sweden and the U.S.A.

2.51 *Aims of the Project*: The primary aim of the project was to investigate the outcomes of various school systems by relating as many as possible of the relevant input variables (to the extent that they could be assessed) to the output assessed by international test instruments. In most countries rapid changes are occuring such as revolutionary modifications in political-philosophical systems and socio-economic and technological systems. So another aim of this project was to study how mathematics teaching and learning have been influenced by such developments.

2.52 *Sampling Design:* The target populations were defined according to their age and grades in which there were maximum number of students of a particular age.

The primary sampling unit was a school in a given country. The procedure of sampling was stratified random sampling. However in some countries the method was selective in nature. Non-response ranged from 0% to 30% in the countries.

2.53 *Tools:* There were ten separately prepared test booklets, graded in difficulty and each given the time-limit of one hour. While developing the tools IEA project staff had to consider the diversites of curriculum, language, method of teaching etc. This situation was more or less similar to the one faced in the MAS project. There too, syllabi from different states were considered in order to arrive at a consensus about the objectives in mathematics education — details of which will be discussed in the subsequent chapters. The total number of items was 174, most of which are multiple-choice type. Separate answer sheets were provided. Apart from the tests there were student opinion booklets consisting of two descriptive scales to get the information of mathematics teaching, school and school learning; and five attitude scales to measure some of the effective outcomes of education: (i) attitudes towards mathematics as a process, (ii) attitudes towards the difficulty in learning mathematics (iii) attitudes towards place of mathematics in society (iv) attitudes towards school and school learning (v) attitudes towards man and his environment. Further four questionnaires: (i) Student Questionnaire, (ii) Teacher Questionnaire, (iii) School Questionnaire and (iv) National Case Study Questionnaire were constructed to gather information about environmental factors *viz.*, the home, the school and the structure of the educational system. All the data was processed with the help of electronic computers. Apart from the exhaustive analysis of the data collected, one of the next features of this project was formation of a Data Bank.

For the details of the project findings the readers may refer to the IEA Project Report published recently (Husen 1967) while an extensive review of this project is published elsewhere (Kulkarni, 1968). In view of the importance of the project, relevant findings will be referred to in the subsequent chapters.

CHAPTER III

PREPARING THE TABLE OF SPECIFICATIONS

3.1 Analysis of the Syllabi

3.11 In India, education is a State subject. The Departments of Education in the various States prescribe syllabus and recommend list of textbooks for primary, middle and high school levels. In a few States, the Department also prepares the textbooks which are then prescribed for use by all the schools. But in most of the States especially at the middle and high school levels a list of textbooks is recommended and the schools are free to use any one or more books from the list. The Matriculation or equivalent examination in most of the States is conducted by the State Departments of Education or in some States by the universities. In some States there is a common middle examination as well. These external public examinations indirectly require the schools to follow the prescribed syllabus. The syllabuses from different States differ to some extent.

The syllabuses from different States were obtained and analysed by the project staff to study their similarities and differences.

3.12 Objectives as Stated in Syllabi

When these syllabi were studied, it was observed that most of them do not mention educational objectives at all. They mentioned only the topics. In cases where the statement of objectives were provided, these were in many cases rather vague like "making a good citizen". Some syllabi however did describe objectives in more operational terms.

State A
- (*i*) To develop the ability to solve common problems in arithmetic and geometry related to home and social life.
- (*ii*) To develop interest for some vocation and to train in keeping correct account of differents individual and group activities.
- (*iii*) To train in clear, logical and critical thinking.
- (*iv*) To develop the attitude to work correctly.
- (*v*) To develop problem-solving skills.

State B
- (*i*) To inculcate habits of an objective search for truth.
- (*ii*) To develop accuracy, logical thinking and reasoning.
- (*iii*) To inculcate the habit of working systematically.
- (*iv*) To promote the power of concentration in the students.

(*v*) To help the students understand the practical utility of the subject and enable them to apply the power of the same in everyday life.
(*vi*) To create a sense of neatness and to promote abstract thinking.

State C (*i*) Skill in the four fundamental operations with numbers and letter numbers.
(*ii*) Knowledge of the primary concepts, facts, relations, operation symbols, etc., of mathematics.
(*iii*) Ability to make use of mathematical knowledge in the solution of the problems in the classroom and outside.
(*iv*) Ability for estimation of measurements and approximation of answers to problems.
(*v*) Ability to check answers.
(*vi*) Ability to represent verbal statements by diagrams and symbols.
(*vii*) Ability to interpret diagrams and symbols.
(*viii*) Ability for logical thinking, i.e., to analyse a problem to select relevant facts and reject others and to solve problems by using principles learnt.
(*ix*) Ability to find out the principles involved in a procedure.
(*x*) To develop habits of accuracy, precision, speed and neatness.

State D (*i*) Knowledge of mathematical concepts, facts, procedures, symbols and principles.
(*ii*) Ability to apply mathematical knowledge to problems in the classroom, in the world outside and in the study of the sciences.
(*iii*) Ability to represent verbal statements by graphs, symbols and diagrams.
(*iv*) Ability to analyse a problem, select the relevant facts, reject the irrelevant ones, solve it by the application of principles already learnt and give a synthetic proof wherever necessary.
(*v*) Ability to interpret graphical, symbolic, and diagrammatic representations.
(*vi*) Ability to find out the principles involved in the steps of given procedures.
(*vii*) Ability to verify results wherever possible.
(*viii*) Capacity for estimation and approximation.
(*ix*) Habits of precision, accuracy, speed and neatness.
(*x*) Ability to appreciate the beauty, rhythm and symmetry of mathematics.

3.2 Classification of Objectives

The objectives at the various stages included in the State syllabi were categorised and reformulated by the project staff for the purposes of these tests. These objectives are given below:

1. Knowledge and understanding of terms, concepts, principles, relationships, symbols.
   Recognition and defining of key words and phrases.
2. Skills
   - (*a*) Computational processes of squaring, cubing, square-root, cube-root, factoring, solving equations.
   - (*b*) Skills in reading the graphical data.
3. Application of knowledge and skill to new situations—novelty of the situation.
   - (*a*) Awareness of the interrelations among the branches of mathematics.
   - (*b*) Solving problems by combining different branches of mathematics.
   - (*c*) Verifying results.
   - (*d*) Approximations.
4. Logical reasoning
   - (*a*) Analysing "if-then" arguments in terms of basic assumptions and conclusions which logically follow.
   - (*b*) Distinguishing between conclusions which do or which do not follow logically from a given set of assumptions.
   - (*c*) Recognising unwarranted analogies.
   - (*d*) Identifying necessary and sufficient conditions.
   - (*e*) Detecting unstated assumptions.
   - (*f*) Recognising inadequate data in generalisations.
   - (*g*) Distinguishing between relevant and irrelevant data.
   - (*h*) Interpretation of data.

3.3 Analysis of Content Areas

As regards the statement of mathematical content in the syllabi, they were usually arranged under topics further divided into sub-topics. Most syllabi did not clearly define the scope of a topic. The material in the syllabi was usually arranged classwise. But not much is said about the learning activities or sequences within a class.

3.4 Working Papers for the National Advisory Committee

After the scrutiny of the syllabi, the following working papers for the National Advisory Committee were prepared to enable it to frame the Table of Specifications.

- (*i*) A consolidated statement of the common and less common topics at primary, middle and high school stage. This is given in Appendix 3.1.

(*ii*) For each one of these topics a detailed analysis, defining the scope of that topic both in its breadth and depth, was prepared. This ran into more than a hundred pages. A specimen of this analysis for the topic on decimals at middle stage is given in Appendix 3.2.

This analysis was done with the help of some teachers in Delhi schools. The working papers and comparative statements of syllabi were prepared without making any value judgements. All these statements were presented to the National Advisory Committee.
(The composition of the National Advisory Committee has been described in Chapter I).

The National Advisory Committee met in January 1964 at Poona. This committee discussed the objectives and the content of the various State syllabi. The major objective of the project was to survey the present status and also to use these tests again after some years to assess the achievement. With this in view, the Committee had decided to chop the deadwood and to introduce some new topics even though they are not found presently in the syllabi of all the States, but are likely to be introduced in

TABLE 3.1

Number of Items in Different Cells of Table of Specifications for Primary Level Tests

Sr. No.	*Objectives/ Content Area*	*Knowledge (I)*		*Skill (II)*		*Application (III)*		*Logical Reasoning and Interpretation of Data (IV)*	
		PI	*PII*	*PI*	*PII*	*PI*	*PII*	*PI*	*PII*
1.	Numeration & Four Fundamental Operations	1	1	3	3	1	1	3	3
2.	Units	1	—	—	—	7	7	—	1
3.	Fractions & Decimals	1	1	4	4	4	3	1	2
4.	Factors & Products	2	2	1	1	—	—	—	—
5.	Family Budget	—	—	—	—	1	1	1	1
6.	Simple Proportion	—	—	—	—	1	1	2	2
7.	Percentage & Simple Interest	—	—	—	—	5	5	1	1
8.	Profit & Loss	—	—	—	—	1	1	2	2
9.	Estimation					—	—	1	1
10.	Geometry	1	1	—	—	1	1	3	3
11.	Integrated Problems	—	—	—	—	—	—	1	1
	Total	6	5	8	8	21	20	15	17

the syllabi in the next few years. The Tables of Specifications as in the final survey are given in Tables 3.1, 3.2 and 3.3 for primary, middle and high school levels.

TABLE 3.2

Number of Items in Different Cells of Table of Specifications for Middle Level

Objective/Content (Topics)	*Knowledge* (*I*)		*Skill* (*II*)		*Application* (*III*)		*Logical Reasoning & Interpretation of Data* (*IV*)	
	*M*1	*M*2	*M*1	*M*2	*M*1	*M*2	*M*1	*M*2
1	2	3	4	5	6	7	8	9
1. Numbers	2	2	4	5			2	1
2. Average					2	2		
3. Percentage, Profit and Loss					3	3	1	1
4. Simple & Compound Interest	1	1			1	2	1	
5. Ratio & Proportion					4	4		
6. Speed					2	2		
7. Area & Volume					4	4		
8. Graphs of Statistics			2	2				
9. Symbolic representation	2	2		1	1	2	3	1
10. Four Fundamental Operations			4	5	1			
11. Laws and Assumptions					2	2	2	2
12. Simple Equations and Problems					2	2	2	2
13. Simultaneous Equations and Problems							1	1
14. Formulae					1	1		
15. Graphs			3	3				
16. Solids	1	1						
17. Lines	2	1					1	1
18. Angles	1	2					1	
19. Properties of Triangles, Quadrilaterals,		1			4		3	6
20. Integrated Problems			3	3	2	1	2	2
Total	9	10	16	19	29	25	19	17

N.B: Some items were put under more than one topic.

8409

TABLE 3.3

Number of Items in Different Cells of Table of Specifications for High School Level

Objective/Content	*Knowledge* (*I*)		*Skill* (*II*)		*Application* (*III*)		*Logical Reasoning & Interpretation of Data* (*IV*)	
	*H*1	*H*2	*H*1	*H*2	*H*1	*H*2	*H*1	*H*2
1	2	3	4	5	6	7	8	9
1. Square Root and Cube Root	1		1	1				
2. Ratio and Proportion		1			4	3		
3. Interest, Present Worth & Discount, Stocks & Shares	2	3			3	3	1	
4. Area & Volume					4	4		
5. Algebraic Laws and Four Fundamental Operations		1	4	3			1	2
6. Products and Factors			3	3				
7. Function	2	1						
8. Simple Equation, Simultaneous Equation and Problems		1	1	1	4	4		
9. Graphs		1	1	1	1			
10. Quadratic Equation	1	1	1	2	1			
11. Ratio and Proportion	1	1						
12. Elimination			2	2				
13. Surds	2			2				
14. A.P. & C.P.					1	1	1	1
15. Logarithm	2	1	1	1				1
16. Angles at a Point	1	1			1			1
17. Parallel Lines					2	2		
18. Triangles and their properties	1				3	2	4	7
19. Polygon & Parallelogram	1				1	2		
20. Areas					1	2	1	
21. Loci	1	1						
22. Circles & Tangents		1					2	1
23. Trignometry	2	2	2	1	1			
24. Integrated			2	1	6	7	2	2
	17	16	18	18	33	30	12	16

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CHAPTER IV

ITEM WRITING

4.1 Item Writers Workshop

As the objective of the project was to prepare Mathematics tests for use in all the States of India, participation of competent item writers from different States was considered desirable at this phase of the project. For this purpose, names of competent item writers were invited from various State Departments of Education, the Department of Field Services, N.C.E.R.T. and from members of the National Advisory Committee. 36 persons out of these lists were invited to attend a 3 week workshop conducted at Almora in May, 1964. (Ref. Appendix 1.4)

The objective of this workshop was to write items for the tests keeping in view the table of specifications. In order to facilitate this work, following working papers were presented:

1. Table of specifications—with the weightage in terms of items, branches of Mathematics and objectives of Mathematic education.
2. Detailed analysis of each topic in terms of concepts, processes, skills, etc.
3. Statements of analysis of errors committed by students.

4.2 Error Analysis

The third set of papers mentioned above and to be referred to hereafter as Error Analysis was prepared on the basis of the results of a pilot study. Keeping in view the table of specifications prepared by the Poona committee, free response type questions were set into 4 different rationally equivalent forms at each level. These were then translated into Hindi, Oriya, Kannada and Marathi languages. These free response tests were administered on a purposive sample of about 100 students per form at the following centres:

Centre	*State*
Mangalore	Mysore
Cuttack	Orissa
Bikaner	Rajasthan
Delhi	Delhi
Poona	Maharashtra

It was felt that the information about the errors usually committed by students would help in devising the distractors to different questions.

Some specimen items used in this study of errors are given in Appendix 4.1.

Some types of errors were anticipated but the actual observation of the answer scripts added many more types. The frequencies of all such types were computed. There were also many errors which could not be categorized under any logical head. Frequencies of such errors were usually very low. A specimen of the proforma used in this analysis is given in Table 4.1.

TABLE 4.1

Proforma for the Study of Errors

Name of the Test. H—4
Serial Number of the Item: 10

Key for brief description of the errors:

A— Finds the volume of the Prism by taking each edge to be 1 m.
B— Confuses the area of the hexagon with the perimeter.
C— Commits mistake in finding out the area of an equilateral triangle.
D— Does not multiply the area of an equilateral triangle by 6 to get the area of the hexagon.

Answer	*Frequency*	*Kind of error (A:B:C etc.)*
Omit	18	
Correct Answer	1	
I cu. m		A
6 cu.m		B
$\frac{\sqrt{5}}{2}$		C
$\frac{26}{10}$	1	
$\frac{13h}{5}$	1	
$\frac{53}{5}$ sq. m	1	
Incomplete	2	

These proformas of error analysis were provided to the item writers at Almora. The item writers were told to use these analysis in writing distractors wherever necessary although they were permitted to write other distractors which may not have been suggested by the error analysis.

4.3 Instructions for Item Writers

As noted in the previous chapter, the multiple choice format was accepted for item writing. In order to have a common format in writing such items a detailed note on how to write multiple-choice items for such tests and some illustrative items were distributed to the item writers. This note and specimen items are given in Appendix 4.2.

TABLE 4.2

Allocation of Items to Different Formats at Primary Level

Item Formats within Multiple Choice	*Test P I*	*Test P II*
1. Multiple choice	3, 4, 5, 9, 11, 13, 14, 15, 16, 18, 20, 21, 22, 23, 25, 26, 27, 28, 30, 34, 35, 36, 37, 38, 39, 40, 41, 45, 48, 49.	1, 2, 3, 4, 5, 7, 10, 12, 13, 14, 15, 16, 18, 20, 21, 22, 23, 24, 25, 26, 27, 29, 30, 31, 33, 38, 39, 40, 42, 46, 50.
2. None of the above type	1, 2	43
3. Sufficient and insufficient data type	17	19
4. Tabula or data type	31, 32, 33, 42, 43, 44	17, 34, 35, 37, 41, 44, 45.
5. More than one answer type	56, 47	47, 49.
6. Pictorial representation (integration of Arithmetic and Geometry) type	24, 50	28, 47, 48, 49
7. Detecting the not similar type	19	
8. Map reading type	29	32
9. Picture reading	10	11
10. Missing link type	6, 7, 8.	6, 8, 9.

Note: Some items are put in more than one category of item formats.

Anticipating that some of the distractors may not work properly, it was recommended that as far as possible six distractors should be provided including the correct choice. It was also suggested that an item should be written in such a way that it may not require more than a minute and in a few cases two minutes for a knowledgeable student to solve it. Item writers were also urged to write more items for the higher objectives especially for Application and Logical Reasoning. This was done in view of the fact that mortality rate on such items in the item analysis is much higher than for those of knowledge type.

4.4 Screening of Items

Three sub-committees were formed for Primary, Middle and High school levels respectively. There was one common screening committee which screened and edited items for all the levels. This Committee took care of the sequential nature of the tests. Sometimes an item written by primary level committee was put into the middle level pool and or an item written by middle level committee was put in the high school level pool or vice-versa. In other words this committee tried to see that the complexity of item was pitched to the level to which the item will be administered.

All this work, could not, of course, be completed at the Almora workshop. Many of the items written by the item writers in the workshop had to be screened, edited and revised. For many, good distractors had to be found. This work was taken up by the project staff with the help of a few members of the National Advisory Committee. It took another 3 months to finally develop the 4 forms to be utilised in the try-out.

TABLE 4.3

Allocation of Items to Different Formats at Middle Level

Item Formats within Multiple Choice	*Test M* 1	*Test M*2
1. Multiple choice	1, 4, 5, 8, 9, 12, 13, 15, 17, 18, 20, 30, 31, 34, 36, 38, 51, 53, 59, 61, 66, 67, 68.	1, 4, 7, 13, 18, 20, 22, 24, 26, 30, 31, 33, 35, 36, 38, 41, 49, 51, 53, 57, 63, 70.
2. None of the above type	2, 3, 6, 11, 16, 19, 21, 22, 23, 24, 26, 35, 37, 39, 40, 42, 44, 46, 52, 54, 62, 63, 64, 65, 70,	2, 3, 5, 6, 8, 10, 11, 12, 14, 15, 16, 21, 29, 39, 45, 46, 48, 50, 54, 61, 62, 65, 66, 68.
3. Sufficient and insufficient data type	7, 14, 25	17, 25, 34, 60
4. Tabular-data type	10,32	
5. Reading and interpreting graphs type	27, 28, 29, 49, 50	27, 28, 29, 47, 48,
6. Steps in sequence type	55	55
7. Necessarily and always true type	56,60	39, 56, 62, 64
8. Detecting wrong/not correct statements type	58	52, 59
9. If-then type	45	37, 43, 54
10. More than one answer type	33, 43, 48, 69	55, 69
11. Pictorial representation (Integration of different branches of Mathematics) type	19, 69	2, 9, 66, 19, 68, 69
12. Passage Comprehension type	21	23
13. Forming equation/expression type	47	42, 44, 45, 47

Note: Some items are put in more than one category of item formats.

4.5 Item Types

As it finally turned out, the tests have the following 16 item types within the general framework of the multiple choice item format:

1. Multiple Choice—usual type.
2. None of the above type.
3. Sufficient and insufficient Data type.
4. Tabular data type
5. Reading and interpreting graphs type
6. Steps in sequence type

7. Necessarily and always true type
8. Detecting not correct statements type
9. If-then type
10. More than one answer type
11. Pictorial representation (Integration of different branches of mathematics) type
12. Detecting the not-similar type.
13. Passage comprehension type.
14. Forming equations/expression type
15. Map reading type
16. Missing link type

Number of items distributed over these types per form and level of tests as they appear in the final tests are shown in Tables 4.2 through 4.4.

TABLE 4.4

Allocation of Items to Different Formats at High School Level

Item Formats within Multiple Choice	*Test H I*	*Test H 2*
1. Multiple choice (usual type)	1, 2, 3, 9, 11, 12, 13, 14, 16, 19, 31, 32, 33, 34, 37, 40, 44, 47, 49, 50, 53, 54, 58, 59, 60, 62, 64, 67, 68, 71, 74.	2, 4, 5, 6, 9, 13, 14, 15, 20, 21, 23, 25, 26, 32, 35, 36, 37, 40, 43, 44, 46, 50, 51, 53, 56, 57, 58, 59, 61, 62, 64, 67, 69, 70, 72, 74, 75, 76, 77, 80.
2. None of the above	4, 8, 10, 15, 18, 23, 26, 27, 29, 30, 39, 41, 42, 51, 52, 56, 63, 65, 66, 69, 72, 73, 75, 76, 77, 78.	1, 3, 7, 10, 11, 12, 22, 28, 33, 38, 42, 45, 47, 48, 49, 52, 60, 63, 73, 78, 79.
3. Sufficient and insufficient data type	5, 7, 45, 46, 66	19
4. Tabular-data type	48, 70	24, 71
5. Reading and interpreting graphs type	35	39, 41
6. Steps in sequence type	27	
7. Necessarily and always type	52, 55, 57, 63	27, 52, 55, 66, 68
8. Detecting wrong/not correct statements type	27	
9. If/then type	20, 22	25, 29
10. More than one answer type	24, 25, 36	22, 30, 31, 54
11. Pictorial representation (integration of different branches of Mathematics) type	17,35	16, 18
12. Detecting the non-similar type	21, 38	65
13. Passage Comprehension type	61	34
14. Forming equations/expressions type	6, 18, 28, 43, 79, 80	7, 8, 17

Note: Some items are put in more than one category of item formats.

It could be seen from these tables and from the screening of the tests themselves that a variety of item-formats appropriate to the objectives and content of the test have been used.

CHAPTER V

THE TRY-OUT

5.1 Preparation of the Forms for Try-out

5.11 *Number of Items Required* : As a final requirement of the project, two equivalent forms at each level were to be developed. The number of items proposed by the National Advisory Committee for these tests for each form are given below:

Primary level	: 50 items
Middle level	: 75 items
High School level	: 100 items

As such 100 items for the two forms at the primary level, 150 for the middle and 200 for the high school were needed. In order to get these items for the final tests, it was considered desirable to start with a larger pool of items at the try-out. It was expected that the mortality rate of items in the try-out of this project would be rather high for the following reasons:

1. The objective type tests are not common in India.
2. The curricula for different levels vary from State to State.
3. Even within a given State, schools introduced topics at their own convenient time and according to their teaching strategy. Thus at a given moment all students in a given class from a given state would not cover the same topics.
4. The tests were proposed to be forward-looking and as such some items would be there from topics that are not taught or emphasised in all the states.
5. The real life situations in the application type items may vary from State to State thereby reducing the suitability of an item in a given State.
6. There is usually more than one dialect within a given regional language of a State and, therefore, a regional language used in a test may not be understood by some students claiming to speak that regional language.

Considering all these reasons, it was felt that it would be better to start with nearly double the number of items that were finally needed. This meant that the try-out forms should have nearly 200 items for the primary level, 300 for the middle level and 400 for the high school level. It was, however, pointed out that it would be difficult to ask the same student to work on such a large pool of items. Schools may resent a student spending so much time on testing or students themselves may get bored. Hence following Lord's suggestion four forms having an equal number of items were prepared at each level. One student was expected to take only one form.

5.12 *Assignment of Items*: Items were assigned to these forms in a manner so as to make them rationally equivalent in terms of content and objectives. The forms separately and together represented all the cells in the table of specifications.

Five common items were also placed in these forms at each level. This was done so as to get item statistics, difficulty-values and discrimination indices which could be compared to decide whether the different groups taking these forms at a given level could be considered as matched. The subsequent results show the groups could be considered as matched.

In addition to the common items over all the forms, there were some items which appeared in two forms. It was felt that the large number of items in the test may give rise to fatigue in the students and thus affect the results especially of the items at the end. To take care of this, last 5 items of each form were placed at earlier position in the subsequent forms.

5.2 Printing of Tests

5.21 *Printing English Version:* The item analysis results from different states could be considered comparable and deviations etc., could be associated to the achievement or curriculum variations only if variables like the position of items throughout different tests, the number of distractors, the testing procedures etc. were uniform. As such, it was necessary to have the same format of tests throughout the country. Same arrangement of items would also facilitate the processing of the data.

As such, it was decided to print English version of the tests first. This would then serve as a model format for printing tests in other regional languages. The final arrangement of items was decided on the following considerations:

(i) The test should start with easy items.

(ii) The stem and all the distractors should appear on the same page.

(iii) If two or more questions are based on a table or certain given information, they should be printed on the same page or pages facing each other.

(iv) Questions pertaining to the same subject matter area should be clustered whenever possible.

(v) Broadly speaking, the Mathematical content was grouped into four groups: Arithmetic, Algebra, Geometry and Integrated problems based on any two or more of these branches. Items were classified as pertaining to these branches.

5.22 *Arrangement of Distractors;* The minimum number of alternatives in the test was 4 and the maximum 6. These alternatives appeared at A, B, C, D, E or F. To ensure that the correct answer would not appear at any one of these letters more frequently than others and thus create a bias in responses, the correct answers were arranged randomly. This procedure of random placement was however not followed in cases where certain logical order e.g. numbers in either ascending or descending order was possible.

5.3 Translation in Different Regional Languages

This being an all-India Survey and the medium of instruction being the regional language in most of the schools, in the States it was decided to print the tests in all the important regional languages. Thus one big task in the Survey was translation of tests into regional languages.

5.31 *Translation:* Persons were selected from different States to take care of the work involved. (Ref. Appendix 1.5) What was stressed in the translation was making the situations real life situation as much as possible without sacrificing the mathematical equivalence of an item as provided in the English version. Detailed instructions in this regard were prepared and sent to the selected translators. (Ref. Appendix 5.1).

5.32 *Evaluation:* Most of the regional languages have more the than one dialect. The spoken language of one part of a state may not be same as that of another. Hence, it was felt that a translator may possibly not be able to do justice to all these different nuances in a given language. To facilitiate his work and to make translation more understandable, three and sometimes four evaluators were appointed for each State to go through the work of a translator and to suggest modifications in words, sentences or situations in the translation. The instructions given to evaluators are set out in Appendix 5.2. The evaluator's comments as consolidated in a proforma developed for the purpose were sent to the co-ordinator helping the project work for being taken care of in finalising the translated versions of the tests. The proforma also is attached with the instructions.

5.4 Directions and Practice Item Booklet

5.41 *Nature of the Booklet:* Objective-type tests are rather new to the school-going population in India. As such, it was felt necessary that the students be given adequate practice on the format before they actually take the test. For this purpose, it was decided that a separate "Directions and Questions for Practice' booklet be developed. This booklet contained directions that explained the procedure to the students. It also contained some practice items. In the primary level booklet there were 10 questions for practice. For middle and high school stage, a common booklet was designed which contained 12 questions. Some of these questions were solved explaining how to arrive at the correct answer, the way of marking answers, etc. The questions at the end were to be solved by the students themselves, with or without the help of their teachers. These practice items covered most of the item formats, referred to in Chapter IV.

5.42 *Number of Practice Items Required:* An important question arose regarding the amount of practice necessary before students can be said to be familiar with the tests in multiple choice format. For this purpose a pilot study was conducted in two schools in the urban area and two in the rural area around Delhi to study this aspect (Jain, 1966). Four separate booklets containing the same directions, but varying number of practice terms viz. 10, 20, 30 and 40 were developed. About 404 fifth grade students participated in this study. Students in each school were divided into four matched groups on the basis of the scores obtained in their previous examination. The four groups thus formed were assigned randomly to different treatments i.e. four practice booklets. The same process was replicated in all the four schools.

After these four separate practice booklets were administered to these four groups, primary level mathematics achievement test was administered to all the four groups and their mean achievements were compared for each school. No significant results were found as revealed in Table 5.1.

TABLE 5.1

Effect of Practice Items on Mathematics Achievement

Group	*Means for treatments* X1	X2	X3	X4	*F-ratio*	*Result*
Urban						
School (1)	16.6 (50)	16.3 (47)	15.6 (50)	16.2 (54)	4.7	N.S.
School (2)	15.9 (20)	20.7 (20)	16.5 (24)	17.0 (23)	3.2	*
Rural						
School (3)	23.1 (19)	23.2 (19)	21.2 (19)	21.1 (19)	3.1	N.S.
School (4)	18.5 (10)	18.7 (11)	20.3 (12)	21.0 (11)	3.1	N.S.

*Not significant at 1% level but significant at 5% level.
N.S.: Not significant at 5% level.
Figures in brackets denote the number of students in a particular treatment group.

On the basis of this study it was decided to retain 10 or 12 practice items in the booklet representing different item formats in the test.

5.5 Testing Procedure

5.51 *Duties of the Supervisor*: As described above, there were four forms of a given level test and a directions and practice items booklet for each level. As it was known that many teachers and students were not familiar with the multiple choice tests, special supervisors were selected to conduct the try-out. These supervisors had previous experience of conducting psychological tests. In the pre-try-out stage and even in the try-out stage for some States, the project staff themselves worked as supervisors.

5.52 *Duties of the Invigilator:* In most cases, the supervisors were from outside the school. In order to have a rapport with students, it was suggested that in addition to a supervisor a class teacher should work as an invigilator. The duties of the invigilator were as follows:

(i) Explaining directions and sample items to students.
(ii) Distributing and collecting the tests.
(iii) Invigilating and explaining the difficult technical terms.
(iv) Filling in the Item Evaluation Proformas.
(v) Filling in the Glossary.

The detailed note sent to invigilators is given in Appendix 5.3.

5.53 *Directions and Questions for Practice*: These booklets were usually administered to students a day or two prior to the testing proper. There was no time limit fixed for this. The supervisor or invigilator was to read the directions along with the students and then encourage them to solve the practice items by themselves.

5.54 *Distribution of Test Booklets*: Before distributing the text booklets, a supervisor or invigilator was to ensure that each student has understood how to answer questions in the test.

There were four forms of tests for each level. Each student, however, was to work on any one of these forms. Invigilator were ased to distribute the tests in the following manner: To the first students in a row, anyone of the 4 forms was to be given. To the next student the form next in order was to be given. For example, if an invigilator gives form II to the first student, he should give form III to the second student and so on. This arrangement was made for two reasons:

(i) To reduce copying by students sitting together.
(ii) To get more or less matched groups to work on the separate forms.

5.55 *Invigilation:* As far as possible Mathematics teachers were appointed as invigilators. They were asked to help students in understanding the language of a test. That is to say if a certain word, technical or otherwise, was not commonly used in a given regional language, the invigilator was asked to give an equivalent word he used with his students and report all such words in the item evaluation form.

5.56 *Time Limit*: There was no fixed time limit for the try-out tests. Students were allowed as much time as they required to solve all the items. However, when 90% of the students completed a test, an invigilator was given the option to ask the remaining ones to stop after waiting for 10 minutes or so. On the basis of the reports received it could be said that the primary level tests usually took less than 2 hours, the middle level tests took nearly 3 hours, while the high school leveltests took nearly 4 hours. Anticipating this, invigilators at high school level, were asked to give a break of ten minutes or so if necessary, in between the 2 hours sessions.

Invigilators were asked to report the exact time taken by 90% of the students to complete the answers. These data helped in finalising the time limits during the final survey.

5.57 *Glossary*: A glossary was prepared by the project staff giving regional equivalents for the English technical terms used in the tests. The invigilators were requested to modify a given glossary in the light of their experience in try-out. They were also asked to suggest any other change in the translations so as to increase the readability of the test in the given regional language. As an illustration, a glossary for the high school level is reproduced in Appendix 5.4.

5.58 *Item Evaluation Proformas*: An item evaluation proforma was also developed for comments by invigilators regarding the items in the tests. He could give therein, his perception about the difficulty of an item and reasons for it. This proforma is reproduced in Table 5.2.

TABLE 5.2

Item Evaluation Form

Mathematics Achievement Surveys.

Test form —————— Class——————

Name of Teacher——————————————

Address of the School ——————————————

Q. No.	*E or D*	*Not in Syll.*	*Not taught*	*Taught casually*	*Topic difficulty*	*Language*	*Situation*	*Suggestions*	*Other comments*
1	2	3	4	5	6	7	8	9	10
1.									
2.									
3.									

Detailed instructions regarding the testing procedure and how to fill in item evaluation proforma were given to the supervisors/invigilators. (Ref. Appendix 5.5)

5.6 Sampling Design for the Try-out

5.61 *Variables:* The major objective of the try-out was to gather data for the purpose of item analysis. Information regarding item difficulty and discrimination as well as information about any language difficulties in an item were also required. In order to fulfil these objectives a purposive sample of schools from different States was selected. It was pointed out earlier that there may be different dialects in a language. In order to get the information about language difficulties it was hence necessary to select schools from different regions in a given State. The sector (urban and rural) variable was also important from the point of view of getting information regarding language difficulties as well as information about situations involving real life. If one has to use the same test in both urban and rural areas one must take care that situations used in items are not unfair to a particular group unless application to that specific real life situation is stated as a desirable goal. Considering this aspect, it was decided to take schools from both urban and rural areas from different language regions of a given State.

5.62 *Grades to which Tests were Administered:* It was anticipated that the tests would most probably prove to be difficult. Hence if the tests would have been administered only to grade V at the primary level, grade VIII at the middle level and matriculation at the high school level, it was feared that on many items there would be no response at all or many responses would be wrong. This would have increased the difficulty of items lowering their discrimination value. On the other hand the tests being sequential, they also included items representing syllabi of lower grades. As such it was decided to administer these tests to students ranging widely in ability/achievement. Hence try-out samples were chosen from the following grades depending upon school structure in the States and times of testing.

Primary level	IV, V, VI and VII
Middle level	VII, VIII and IX
High School level	X (matriculation) and XI-(Ist year college)

5.63 *Size of the Sample:* For the item analysis purposes, it was decided that about 400 bits of information should be available for each item, in each language version. That is to say about 400 students were required to take up each form and so about 1600 students for each level. As such, from each State an adequate number of schools from the variable mentioned above were selected. Similar data were also collected from schools belonging to the Central Schools Organisation and from Public Schools.

It may be noted here that the try-out could not be conducted in all the States. In a few centres of some States although the try-out was conducted, the data could not reach Delhi before the second meeting of the National Advisory Committee, due to various administrative reasons. As such there are certain gaps in the sample. However, looking at the data from the total country as a whole it was adequate enough to carry out item analysis and select the items for the final tests.

CHAPTER VI

ITEM ANALYSIS AND PREPARATION OF TWO EQUIVALENT FORMS

6.1 Item Analysis

6.11 *Purposes of Item Analysis:* In this study, the item analysis of the try-out data was taken to fulfil the following purposes:

(i) To weed out bad items
(ii) To locate distractors which are not working properly
(iii) To get data for constructing two equivalent forms

Items in the test may not be functioning in the proper direction for variety of reasons like: (i) the mathematical content may be wrong or inadequate, (ii) the language used may be ambigious or misleading, (iii) the translation in the regional languages may be cumbersome or faulty and (iv) the real life situations used in application items may be completely unfamiliar to a given group of students.

The second purpose of the item analysis as mentioned above is to see if the distractors are working properly. It was anticipated that some of the distractors may not be proper. As such most of the items in the try-out forms had more than four alternatives. The item analysis data for each State was considered for this distractor analysis also.

6.12 *Item Analysis Work Sheet*: In order to serve both these purposes the item analysis data was recorded in a proforma given in Table 6.1.

It may be noticed here that the proforma includes in addition to the statistical information on each item the information collected from teachers regarding the language difficulty of an item. Supervisors conducting the tests were also asked to interview the teachers and take their opinions independently about the working of an item. Did the teacher feel that an item was difficult or easy? If he felt that the item was difficult, was it due to the reason that the topic was not taught or, if taught, it was not taught very intensively? Or, was it difficult because the language was cumbersome and misleading ? Or was it difficult because the real situation used in the item was unfamiliar ? Supervisors were urged to get any other non-mathematical reasons adding to the difficulty of an item. This information was necessary because with item statistics from 12 different populations an item might show less discrimination for such non-mathematical reasons too. Hence the item statistics were considered in the context of such comments by teachers. The information from the 12 States was consolidated in a proforma given in Table 6.2.

TABLE 6.1

Proforma for Item Analysis Work Sheet

Item No.	*Choices*							*Item Statistics*	*Teachers comments on difficulty*						
	O	*A*	*B*	*C*	*D*	*E*	*F*		*Difficulty*	*Topic*	*Language*	*Situation*	*Other difficulties*	*Selected or not*	*Remarks*
TS								Difficulty index ——							
UG								Discrimination index ——							
LG															

TS: Total Sample UG: Upper 27% Group LG: Lower 27% Group

TABLE 6.2

Proforma for Consolidating Item Statistics Information from Different States.

Indentification of Item		*Item Characteristics*	*States*										*Punjab*					
			A.P.	*Asm.*	*Bhr.*	*Gjt.*	*J&K*	*Krl.*	*M.P.*	*Mds.*	*Mhr.*	*Mys.*	*Pun.*	*Hindi*	*Rjs.*	*U.P*	*W.B.*	*Engl.*
Level	Form																	
—	—	Diff. ——																
Topic No.	Obj. No.	Disc ——																
—	—	Omit ——																
		NR ——																

6.13 *Scoring*: The tests were scored by the simple scoring system of one mark for the correct response and zero otherwise. Corrections for guessing formula was not used as the number of items in the tests were sufficiently large.

6.14 *Format for Item Analysis*: The difficulty indices were calculated according to the percentage of the correct responses. The discrimination indices were calculated on the basis of upper and lower 27% of the total group and then using the Harper's chart for getting the discrimination indices.

6.15 *Sample for the Item Analysis*: As described in Chapter V, the try-out sample was chosen for the specific purpose of item analysis, as such no sub-sample was drwan out of the try-out sample. In most of the cases, out of twelve States there were about 300 students who responded to each of the items in the tests.

6.2. Selection of the Items

6.21 *National Advisory Committee Meeting:* The National Advisory Committee met again in April, 1966 at Bhopal to select items for the final forms. The list of the members who attended the meeting is given in Appendix 1.2.

As a group, the members knew all languages in which try-out forms were prepared. They went through teachers' comments on various items and decided that items could not be selected only on the basis of statistical indices as in some cases the discriminations were low due to extraneous reasons. It was also observed that some items had low discriminations because they were difficult. The committee then had to take a hard decision whether to keep such difficult items even if their discriminations were low. It was pointed out that the tests were to be used for the survey and, therefore, they should be criterion referenced tests rather than norm referenced tests. It implied that even if an item is found to be difficult, it might be retained if it reflected the criterion behaviour—the behaviour considered to be desirable by the experts. It was, however, suggested that while retaining an item on the basis of desirability of criterion, one must be very careful in looking at its indices along with the teachers comments from different States.

6.22 *Item Selection Procedures:* Once the policy decision was taken items were selected by the following procedures:

1. All items with discrimination indices above 20 in more than 9 out of 12 States were considered usable for the final forms. These items, however, were screened again as to their mathematical accuracy by the mathematicians in the committee and were then finally approved.
2. Items with discrimination less than 20 were discussed threadbare in sub-committees appointed for the purpose. Items from this

group with low discrimination because of certain defects in language, situation, etc. were thrown out. But those which did not have any such defect and still had low discriminations in more than 3 States due to low difficulty value (few students getting it correct) were retained.

6.23 *Distractor Analysis:* After the selection of the items the distractor analysis was done by the project staff. Frequency of the distractors as revealed in the State data was considered. Keeping in view the popularity of each distractor and their diagnostic value—identifying errors—three distractors were retained for each item in addition to the correct response.

6.3 Preparation of Parallel Forms

6.31 *Selection of Parallel Pairs:* As mentioned above, one of the purposes of the item analysis was to pair items to develop parallel forms. The situation in this case however was rather different from the traditional situation in which item statistic is obtained from one population only. In this case 12 different populations provided item statistic which varied from population to population. Under these circumstances, the following procedure was followed in preparing two equivalent forms:

1. The items were first sorted out in terms of the content and objective, i.e. according to the cells in the table of specifications.
2. Within these cells, items which were closer in difficulty values were paired. The maximum range of difference between difficulty values of items in a pair allowed was 20.
3. In few cases it was not possible to get a pair within this range. In these cases an item which was more difficult was made easier to be comparable with another item from that cell. This was usually done by dropping a close distractor or by eliminating some elements from the stem which made the item more difficult.
4. The number of pairs selected within each cell is proportional to the weightage of that cell in the table of specifications.

6.32 *Placement of Items in the Two Forms:* The next stage in preparing the parallel forms was to allot items to either form I or form II. As noted above, the difficulty and discrimination values varied from State to State. Hence it was not possible to take into consideration all these values simultaneously and prepare parallel forms for all the States. As such, graphs of frequency distributions of scores for all the States were first drawn and then three States were selected as being representative of these score distributions. These States were Andhra Pradesh, Uttar Pradesh and the English medium schools. The difficulty values of the items as obtained for these three groups were then considered while allocating them to form I or form II. If the difficulty values were

TABLE 6.3

Scatter Diagram of Difficulty and Discriminatory Indices of Items for Maharashtra State (Primary Level)

Less Difficult *Difficulty Value* *More Difficult*

	Interval		99-90		89-80		79-70		69-60		59-50		49-40		39-30		29-20		19-10		9-0		*Total*	
			P1	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*	*P1*	*P2*
High Discrimination	50—59	P1							1				2		1		1						5	
		P2								1				1		1		—						3
	40—49	P1			1				1		2		1		2		2		1				10	
		P2				1				1		1		2		1		3		1				10
Discriminating Value	30—39	P1	—		3		1				2		2		2		3		2				15	
		P2		1		2		—				1		1		3		6		1				15
	30—29	P1	—		1				1		1		1		3		2		2		—		11	
		P2		1		2				—		2		1		—		2		2		2		12
	10—19	P1															—		1		3		4	
		P2																3		1		—		4
Low Discrimination	0—9	P1															1						1	
		P2																1						1
	Total	P1	—		5		1		3		5		6		8		9		6		3		46	
		P2		2		5		—		2		4		5		5		15		5		2		45

Note: Four items in test P1 and five in test P2 were revised and hence they were not included here.

Figures in the cells denote the number of items for particular difficulty value and discriminating value for P1 and P2 more or less equal, allocation of an item from a given pair was done randomly. But if the difficulty values were different the allocation was made in the following manner:

If form I gets an item which is more difficult from one pair, form II would get a higher difficulty item from another pair. After the items were allocated in this manner, the median difficulty was computed for all the three Groups mentioned above. Wherever the median difficulties of the two forms did not come to be almost the same grouping was again done by trial and error method to get two forms of almost similar median difficulties for these three Groups. At the same time dispersion of the difficulty values of the items was also considered graphically. Along with the difficulty values, the content and objective dimensions were also taken into consideration while placing the items in the parallel forms. The Tables of Specifications given in Chapter 3 reveal the equivalence on these dimensions. The Pie graph on page 44 represents the equivalence on the dimension of objectives.

6.33 *Checking the Distribution:* Having thus finalised the two parallel forms by the above procedure, a chart for Maharashtra State was prepared, to see the distribution scatter of both discriminatory indices and difficulty values.

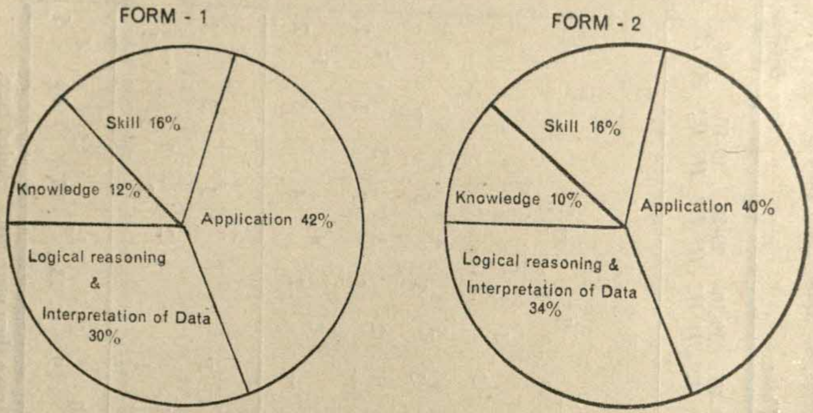
This was done to see if the distributions of these two indices were fairly same for both the forms. Tables 6.3, 6.4 and 6.5 present these distributions for the three levels respectively.

6.34 *Number of Items per Form:* Finally 50 items per form at the primary level, 70 items per form at the middle level and 80 items per form at the high school level were selected. The National Advisory Committee at its first meeting held at Poona had recommended 75 items for the middle level test and 100 for the high school level tests. The decision to reduce this number of 70 and 80 for middle and high school level respectively was taken by the National Advisory Committee at its second meeting at Bhopal. The decision was based on the time taken by the majority of students in completing the tests as recorded in the Invigilation Reports, received from teachers. These indicated that at the high school stage, a hundred itemes test require more than 3 hours and the middle level test comprising 75 items also required in some schools more than 3 hours. The committee favoured the decision to keep the tests as far as possible within the 3 hour time limit and hence reduced the number of items as above.

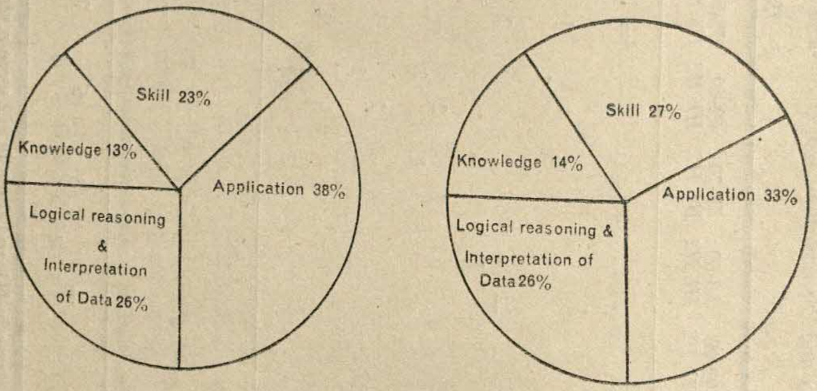
6.4 Seperate Answer sheet for High School Level

In the try-out forms, students were required to give their answers in the test booklets. It was suggested, however, that separate answer sheets could be used by older children of high school group without any difficulty of handling them. This would have reduced printing costs. Hence a separate answer sheet was developed for high school level. Alongwith

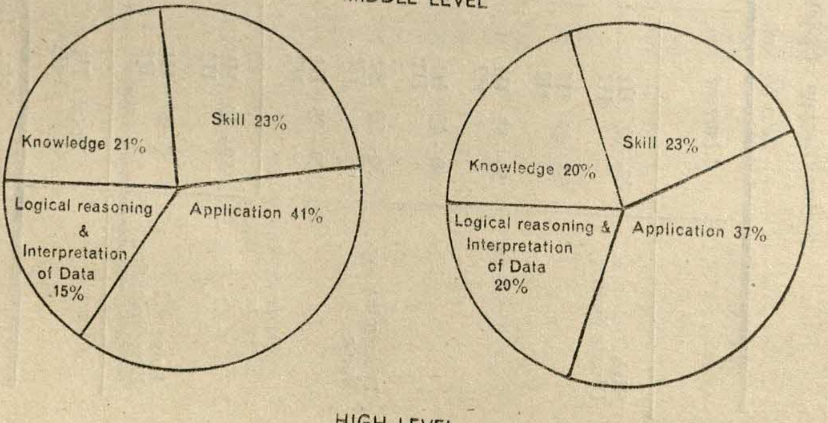
Pie Graph-Item-Allocation (in percents) to different objectives



PRIMARY LEVEL



MIDDLE LEVEL



HIGH LEVEL

the answer sheet a two page questionnaire was printed in English and Hindi. The questionnaire comprised of items related to bio-social data of a student, his aspirations, educational facilities at his disposal and his attitude towards mathematics in particular and towards education in general.

For the primary and middle levels, neither a separate answer sheet nor any questionnaire was developed as it was felt that these students may not be able to handle more than one booklet especially in view of the fact that seating accommodation is very much crowded in many primary schools.

6.5 Printing of Final Forms

The Bhopal Committee had finalised two forms for each level. These were in English. The translations in different regional languages were modified wherever necessary and tests in different languages were finalised. These were then printed in accordance with the arrangement of items and the total pattern of the English version.

CHAPTER VII

SAMPLING

7.1 Sample Surveys

In large scale sample surveys, one has to discover a golden compromise between precision and cost considerations. In many situations the financial resources and time targets will be fixed appriori. Hence one has to adopt a suitable sampling strategy which would provide estimates with higher precission within these limitations.

While conducting sample surveys there are two sampling strategies available: (i) Judgement or Quota Sampling procedure and (ii) Probability Sampling procedure. The advantage of the probability sampling procedure is that standard errors of estimates can be calculated on the basis of internal evidence provided by the sample itself as the probabilities of selecting the sampling units are known, while a sample selected by expert judgement may be better than probability samples but it will not provide any internal evidence for standard errors because the probabilities of selecting the units are not known.

7.2 Sampling Unit

Ultimate sampling unit in any educational achievement survey is the student. Once the sample size is fixed there are two methods of selecting the students. One method consists of selecting less schools or classes and selecting all the students from the school/class. Another method involves selecting more schools and selecting a lesser number of students. An interesting discussion about these two methods of sampling is given in the sampling chapter of IEA report (Husen 1967). It is found that in the case of educational variables the intraclass correlation coefficient—which is a measure of the effect of clustering of students within a school/class—is found to take positive values. This positive intraclass correlation makes the second method of sampling—viz. more schools and lesser number of students within a school—more efficient. While from administrative and economic point of view the first method viz. lesser number of schools and more students from the selected schools—is preferred. However one can arrive at the same efficiency through the first method provided the intraclass correlation is very low. This can be achieved by way of careful stratification. For the MAS project the sampling design adopted was multistage stratified sampling procedure and selecting all the students from a class within a selected school. Stratification was effected on all important variables at different stages so as to make this intraclass correlation coefficient as low as possible.

7.3 Sources of Information for Preparing the Frame of Schools

When this survey was undertaken only a complete list of high schools was available at the national level. The lists of primary and middle schools were not available at the national level and in some cases they are not available even at State headquarters. In some cases the lists of primary and middle schools were available only at the block or tehsil level in rural areas and at the city level in urban areas. Just prior to this project, the Department of Psychological Foundations had tried to collect lists of schools at all the three levels from all the States of India in order to prepare a master sample. From some States lists of schools were received. But in most cases these lists were not complete and did not represent many important regions in a given State.

Simultaneously with this survey of mathematic achievement, another project of surveying educational institutions in India had been undertaken by the Educational Survey Unit of the NCERT. By the time the tests were prepared and were ready for the survey, the Educational Survey Unit had collected lists of schools from many States especially from the rural areas. Thus, the two lists—one prepared for the master sample and the other by the Educational Survey Unit were combined wherever necessary to prepare a total frame for a given State. But in many cases even this combination could not give a total frame for the entire State. In such cases project staff themselves visited the State headquarters to finalise the sample.

7.4 Multi-stage Sampling Procedure

7.41 *States and Regions:* As mentioned earlier the States have different syllabi, educational structure etc. Hence these States were considered as different populations for the survey purposes. All the States of India were selected for the survey except the State of Nagaland and the Union Territories like Manipur, Himachal Pradesh, etc. Delhi was, however, included as a special case being one of the 12 big cities.

Most of the States were re-organised after independence. As such many states can be stratified further into regions having a different educational and cultural history within the same State. Further these regions in many cases have different dialects. Taking into consideration these aspects and the States were further divided into regions after consulting the State authorities. Table 7.1 presents the States which were stratified into regions, the names of the regions and the districts which form these regions.

7.42 *Sector:* The next stage within a region was the urban and rural sectors. The urban sector was defined as cities or towns with a population of 5,000 or more. The rural area was defined as a village with a population of less than 5000. For the survey purpose, a block/tehsil was considered as of a unit in the rural area. In the urban area, cities and towns were further categorised into (i) big cities with population 10 lakh and more, (ii)

TABLE 7.1

Stratification of States into Regions

State	*Regions*	*Districts*
1	2	3
1. Andhra Pradesh	I. Telengana	Hyderabad, Karim Nagar, Khammam Mahabub Nagar, Nalgonda, Nizamabad Warangal.
	II. Rayalaseema	Anantpur, Chittor, Cuddapah, Kurnool, Nellore
	III. Circars	East Godavari, Guntur, Krishna, Visakhapatnam, Srikakullum
2. Gujarat	I. Kutch	Kutch
	II. Saurashtra	Bhavnagar, Junagadh, Rajkot, Jamnagar, Amreli, Surendranagar
	III. Sabarkantha	Sabarkantha, Mehsana, Banaskantha & Broach
	IV. Ahmedabad	Ahmedabad City, District Ahmedabad, Kaira & Panchmahals.
	V. Baroda	Baroda, Bulsar & Surat
3. Jammu & Kashmir	I. Kashmir	Srinagar, Anantanag, Baramulla
	II. Jammu	Jammu
4. Kerala	I. Southern	Trivandru, Quilon, Allepey
	II. Central	Kottayam, Trichur, Eranakulum
	III. Northern	Cannanore, Kozhikode, Palghat
5. Madhya Pradesh	I. Gwalior	Gwalior, Morena, Bhind, Shivpuri, Guna, Datia
	II. Indore	Indore, Dewas, Dhar, Jhabua, Khargonea, Ujjain, Ratlam, Mandsaur
	III. Bhopal	Sehore, Raisen, Vidisha, Rajgarh, Sharjapur
	IV. Mahakoshal	Hoshangabad, Khandwa (Burhanpur) Narsinghpur, Seon, Betul, Chhindwara, Jabalapur, Damoh, Sagar, Mandla, Balaghat.
	V. Chhattisagarh	Raipur, Durg, Bastar, Bilaspur, Raigarh, Surguja (Ambikapur)
	VI. Rewa	Rewa Sidi, Stana, Shahdol, Chhattarpur, Tikamgarh, Panna

1	2	3
6. Maharashtra	I. Marathwada	Aurangabad, Bhir, Nanded, Osmanabad, Parabhani
	II. West. Maharashtra	Kolhapur, Nasil, Poona, Satara, Sangli, Sholapur, Jalgaon, Dhulia, Ahmednagar.
	III. Konkan	Kolaba, Ratnagiri, Thana
	IV. Vidharbha	Akola, Amaravati, Chandara, Chanda, Buldhana, Nagpur, Wardha, Yeotmal
	V. Greater Bombay	Greater Bombay
7. Mysore	I. Bangalore	Mysore, Kolar, Bangalore, Chitradurg, Bellary, Tumkur.
	II. Hasan	Mandya, Chickmagalur, Coorg, Hasan, Simoga
	III. Dharwar	Dharwar, Belgaum, Bijapur
	IV. Gulbarga	Gulbarga, Raichur, Bidar
	V. Mangalore	South Canara, North Canara
8. Orissa	I. Cuttack	Cuttack, Phulbani, Puri and Ganjam
	II. Balasore	Dhenkanal, Keonjhar, Balasore and Mayurbhanj
	III. Korapur	Rolangir, Kalahandi and Koraput
	IV. Sambalpur	Sambalpur and Sundergarh.
9. Rajasthan	I. Ajmer	Ajmer, Alwar, Bhilwara, Jaipur, Jhunjuru, Sikkar,
	II. Jodhpur	Barmer, Jalore, Jodhpur, Nagpur, Pali, Sirodhi, Jaisalmer
	III. Bikaner	Bikaner, Churu, Ganganagar.
	IV. Udaipur	Banswara, Chittorgarh, Dungarpur
	VI. Kota	Bharatpur, Bundi, Jhalawar, Kotah, Swai Madhopur, Tonk
10. Uttar Pradesh	I. Northern	Nainital, Almora, Pauri Garhwal, Pithoragarh, Dehradun
	II. Western	Meerut, Moradabad, Saharanpur, Bulandshahr, Mathura, Muzaffaranagar, Agra, Etah, Jhansi
	III. Eastern	Gorakhpur, Basti, Jaunpur, Deoria, Azamgarh, Ghazipur
	IV. Central	Allahabad, Lucknow, Hardoi, Faizabad, Etawah, Farrukhabad, Raibareli, Fatehpur, Pratapgarh, Kanpur.

N.B. **List of districts for a region include** only those districts from which schools were selected in the sample.

towns with population of 1 lakh to 10 lakhs (iii) towns with population of 10 thousand to lakh and (iv) towns with a population of 5 thousand to 10 thousand.

7.5 Allocation of Schools

7.51 *Number of Students:* From all over the country it was decided to have 2000 schools per level of school education—namely primary, middle and high school. It was further decided that from a school at a given level a section of about 40 students would be included in the survey. However there were some schools having larger number of students on roll and some schools lesser number of students in the sections. This meant that about 80,000 students would be tested at each level. These decisions were taken on the basis of the cost factor.

7.52 *Allocation to States:* The allocation of the number of schools to different States was in proportion to the total number of schools at all the three levels available from the 1961 educational statistics. The number of schools alloted to different States is given in Table No. 7.2.

TABLE 7.2

Number of Schools Allotted, Selected and Responded in Different States

State/ Group	*Allotted*	*Primary level*		*Middle level*		*High School level*	
		Selected	*Responded*	*Selected*	*Responded*	*Selected*	*Responded*
1. Andhra Pradesh	175	180	108	180	103	150	60
2. Assam	50	52	40	52	34	52	29
3. Delhi	30	40	24	46	32	36	28
4. Gujarat	112	98	92	98	93	98	66
5. Jammu & Kashmir	30	31	31	27	27	27	12
6. Kerala	65	65	62	64	62	30	24
7. Madhya Pradesh	150	150	131	150	129	150	105
8. Maharashtra	210	209	190	211	172	188	136
9. Mysore	150	152	127	150	134	151	104
10. Orissa	95	96	85	95	85	92	88
11. Punjab	80	80	61	80	61	80	40
12. Haryana	35	33	30	33	26	33	14
13. Rajasthan	105	102	90	102	92	102	70
14. Uttar Pradesh	200	215	133	215	125	190	79
15. West Bengal	140	110	45	110	58	110	35
16. Central Schools	30	58	46	58	48	58	41
17. Public Schools	30	33	15	33	16	33	16

It may be noticed that in States of Rajasthan, Madhya Pradesh and Bihar the number was restricted to150 schools, although the number should have been higher, had sampling been done strictly in proportion to the total number of schools in these States. This reduction was made in order to have a fairly adequate number of schools in other small States like Assam and Kerala. It was considered desirable that each of the smallest cells in the sampling design for a given State should contain at least 2 schools. In case of some States like Kerala this required a large number of schools than it would have been otherwise allotted to it in exact proportion to the total number of schools in that State. On the contrary this condition could be fulfilled for States like Rajasthan, Madhya Pradesh and Bihar even when the number was reduced to 150 schools per level.

It may be mentioned here that for various administrative and other reasons the survey could not be conducted in the States of Bihar and Madras.

7.53 *Allocation to Regions:* The allocation of schools to different regions was roughly proportional total number of schools in these regions. Whenever this information was not available, the proportion was decided approximately in terms of the number of districts that the region contained. As could be read from Table 7.1, the States of Assam, West Bengal, Punjab and Haryana were not further divided into regions. All other States were however divided into specific regions. The proportion of schools allotted to different regions is recorded in Table 7.3.

7.54 *Allocation to Sectors:* As regards urban and rural sector, the allocation was made on 50-50 basis. This was done to have an adequate number of schools which would enable developing separate norms for the urban and rural sector in a given region. Thus the number of schools in these two sectors in most States also approximates to this ratio.

As described above, the cities and towns in the urban sector were divided into four categories. The big cities of ten lakh and more were treated as a separate category because Municipal Corporations control their educational structure. They have also a large number of schools. Hence it was thought that separate norms should be provided for these big cities. From each of these big cities, to 20 to 40 schools were selected per level. The exact number of schools selected from the big cities per level is given in Table 7.4.

Towns of category 2, 3 and 4 were to be selected by proportionate random sampling methods with 25% representation to category 2 towns and 5% to category 3 and 4 towns each. Not more than 10 schools were to be selected from a given town of category 2 while 2 to 5 schools were to be selected from a given town of category 3 to 4. This was decided mostly from the stand-point of administrative convenience and cost factor. Schools from these towns were selected randomly after getting a complete list of schools in the town chosen for the study.

For the rural areas, it was very difficult to get a frame of schools from

TABLE 7.3

Proportions of Schools Allotted to Different Regions within a State

Region \ State	*Andhra Pradesh*	*Gujarat*	*Jammu & Kashmir*	*Kerala*	*Mahdya Pradesh*	*Maharashtra*	*Mysore*	*Orissa*	*Rajasthan*	*Uttar Pradesh*
I	Telengana	Kutch	Kashmir	Southern	Gwalior	Maharashtra	Bangalore	Cuttack	Ajmer	Northern
	1	1	4	2	6	2	2	3	2	1
II	Rayala seema	Suarashtra	Jammu	Central	Indore	West Mhr.	Hasan	Bangalore	Jodhpur	Western
	1	5	1	2	8	5	1	2	1	5
III	Circars	Sabarkantha	—	Northern	Bhopal	Konkan	Dharwar	Korapur	Bikaner	Eastern
	1	4		1	5	2	1	1	1	3
IV	—	Ahmedabad	—	—	Mahakoshal	Vidarbha	Gulbrga	Sambalpur	Udaipur	Central
		4			11	3	1	1	2	5
V	—	Baroda	—	—	Chhatisgarh	Greater Bombay	Manglore	—	Kota	—
		4			4	3	½		2	
VI	—	—	—	—	Rewa	—	—	—	—	—
					7					

Note: These ratios were same at all the three levels of testing.

TABLE 7.4

Response Position in Big Cities at Different Levels

CITY	*STATE*	*PRIMARY*			*MIDDLE*			*HIGH*		
		Sample	*Response*		*Sample*	*Response*		*Sample*	*Response*	
			No.	*%*		*No.*	*%*		*No.*	*%*
1. AHMEDABAD	Gujarat	20	20	100%	20	20	100%	20	10	50%
2. BANGALORE	Mysore	21	21	100%	20	19	95%	20	6	30%
3. BOMBAY	Maharashtra	45	41	91%	45	31	68%	40	26	65%
4. CALCUTTA	West Bengal	30	13	43%	30	17	57%	30	4	13%
5. DELHI	Delhi	27	19	70%	33	24	73%	28	21	75%
6. HYDERABAD	Andhra Pradesh	25	—	—	25	—	—	22	13	59%
7. KANPUR	Uttar Pradesh	20	11	55%	20	12	60%	20	10	50%

Note: The figures in the Table indicate the number of schools.

all the blocks in the country. Hence, it was decided to select 5% of blocks at random from the complete list of blocks in the country. The master sample project referred to above had already a list of blocks so chosen and in some cases list of schools from such selected blocks. Whenever such lists were available, schools were selected from these blocks. Where these lists were not available, attempts were made through the Educational Survey Unit to get such lists. Where these attempts failed, another block preferably in the same district and/or region was selected and the list of schools in that block was used as a frame.

From each of these blocks, it was decided to have about four to five schools. This was easy to do as far as the primary level was concerned as most of the blocks contain 50 to 100 villages. But when the question came of selecting high schools, in many cases one block had only one high school. In such cases, high schools from neighbouring blocks were selected. It may, however, be pointed out that schools with a strength of less than 25 students were omitted from the frame.

7.55 *Single Teacher Schools:* In many States, the primary level survey was actually conducted on the grade VI beginners rather than the grade V enders. The reasons for these are explained below in section 7.83 This necessitated a list of middle schools and high schools having 6 grades. In some States, there are many primary schools with grades IV or V only. Most of the single teacher schools which constitutes about 37% of the total number of primary schools fall in the category of those having less than 4 or 5 grades. These schools are hence omitted from the population of schools for the survey. It may however be noted that although the percentage of single teacher schools and those providing for 4 or 5 grades only is very high, the proportion of students catered to by these categories of schools is low—about 15% only.

7.56 *Allocation of Schools to Other Variables:* The number of schools allotted to a particular sector in a given region of a given State was further divided in varying proportions into:

(i) Management: Govt./Non-govt, (Govt. includes, schools run by State Govt. and local bodies like municipalities etc.)
(ii) Schools: Co-educational/girls.

The co-educational schools also included the boys schools. No exact information was available from the master sample project about the proportion of Govt/Non-Govt. schools in various regions. Nor was exact information available regarding the proportion of boys versus girls schools. In most cases, however, some information was available on the basis of which broad classifications could be made. For example it was known that in the State of Maharashtra most of the primary schools are managed by Govt/Local bodies while a majority of the high schools are managed by private/voluntary agencies, while in the State of Punjab, the percentage of the high schools managed by the Government is very high compared to that managed by private bodies. On the basis of such information, proportions for the variables of management and sex were decided upon and schools from a given area were selected with this rough proportion in mind.

7.57 *Special Category Schools:* In addition to schools selected from States, two separate populations of schools were also included in this survey. These were:

(i) Central Schools run by the Central Schools Organisation of the Union Ministry of Education
(ii) Public Schools which are affiliated to the Council for Indian School Certificate Examination.

The schools in these two special categories are spread all over India in different States. The Central Schools Organisation follows a syllabus prescribed by the All India Board of Secondary Education and is usually different from the state syllabi. The media of instruction in these schools are both Hindi and English. Public Schools follow again a different syllabus prescribed by the Council for Indian School Certificate Examination and the medium of instruction is English. Because of the differences in syllabi, media of instruction and educational pattern, these two categories were considered as separate population in addition to States.

At the time when the Survey work started there were about 58 Central Schools being run by the Central Schools Organisation for more than three years. (Schools run by Central Schools Organisation for a shorter period may not be affecting students' achievement in any uniform manner.) This being a small number it was decided to include all these 58 schools in the sample.

There were 250 Public Schools affiliated to the Council for Indian School Certificate Examination. Of these 30 schools were selected randomly.

The sample size in both these categories was determined to have adequate sample for normative purposes.

7.6 Biases in Sampling of Schools

The sampling design described above tried to take into consideration the various limitations of cost and administrative conveniences. Over and above these limitations, difficulties were also faced in some instances in getting the cooperation from schools. The reasons for the non-cooperation from a given school were usually the examination time or some other function which was scheduled prior to our request for facilities of testing for the survey. But these cases were few. There were also a few cases where a school selected randomly was in a corner not easily approachable by a test administrator from the town. Under these circumstances, a supervisor was allowed to take up another school with similar characteristics from the same block whenever such substitutes had to be taken. Supervisors were told to select an equal or a little better school, better in terms of the performance and facilities provided rather than selecting a poor school. This bias towards good school was introduced deliberately relying on the experience at the try-out stage. The analysis of the try-out data had revealed that the tests were difficult. If poor schools had been selected, their performance would have been below the guess score. It was therefore felt that even if the level of performance in these supposedly non-poor schools is assessed we shall be able to find out our weaknesses.

7.7 Test Administration Procedure

7.71 *Supervisors/Invigilators:* In most of the States, test administration was arranged through the Department of Education/Public Instruction. Inspectors or the A.D.I's at the district/block level worked as supervisors. For each school, there was one such supervisor, The work of distribution of tests and invigilation was carried out by a class teacher, usually the one who taught mathematics. Prior to the administration of tests proper, the class teacher administered the practice booklet and explained the directions for solving items from these practice booklets.

The supervisors and invigilators were given detailed instructions about test administration. A copy of the these instructions is reproduced in Appendix 7.1.

7.72 *Test Distribution Procedure:* The two forms of the tests were administered to two groups in the same section of a given class. The procedure of distributing tests was similar to the one followed at the try-out. Usually all students of a selected section of a given class in a given school took the tests. Half of the students were given form I and the remaining half form II in such a way that those sitting side by side got different forms.

7.73 *Ability Grouping :* If there were more than one section for a given class in a given school, information was obtained if these sections were formed on the basis of ability. In very few schools sections were formed on the basis of ability. In such cases, supervisors were advised to take up the average section. In schools where there was no ability grouping, the supervisor could select any section at random.

7.8 Limitations in Interpreting the Findings

7.81 *Restriction at the Selection Stage:* As mentioned earlier, schools with section strength of less than 25 for the levels in question were omitted if they appeared while random selection was being made. It is felt that educational awakening is related to the student strength in schools. This implies that exclusion of such schools has led to lesser representation to under developed areas. The sample of schools in this study, therefore, is perhaps better in achievement than the one comprising of schools selected strictly randomly.

7.82 *Non-Response:* The response position from the respective States is given in Table 7.5. The non-response percentage from the different States ranged from 2% to 50%. For example, in case of U.P., the percentage of non-response is quite high—nearly 50%. This happened due to the various strikes and the general disturbances during the election year. Under the circumstances, precision and the accuracy of generalisation about schools in such States, have definitely suffered to certain extent. With the design of this study it was not possible to measure exactly the impact of this non-response error on the precision. Still it seems to us that considering the scatter of schools which responded over the various areas and the variation in the characteristics which they posses, the sample of schools that ultimately responded does give us findings which could be depended upon by an educational planner for group decisions.

While interpreting the norms in an individual case, much caution however shall have to be shown especially for States like U.P. where the non-response error is quite large. It is the belief of the authors that for individual guidance it will be much better if local norms are developed. This work shall have to be taken up later by the local agencies like State Institutes of Education, District/Local Boards, etc., The norms provided in this report will, however, work as guidelines for any such effort.

7.83 *Diversity between States:* It has been already noted in Chapter III that States differ in their syllabi, textbooks, etc. and hence are considered as different populations. One should not, hence compare the performance of different States without taking into consideration this limitation. Another limitation on comparing State performance is the different timings at which the tests were administered. As noted already the end of the educational year in these different States falls in different months. Due to various administrative difficulties like printing delays, etc., it was not possible to conduct the tests in these different States at a specific point chronologically equidistant from the end of the educational year.

The dates on which the tests were administered fall at different chronological distances from the end of the educational year in different States. This resulted in the discrepancy that although in some States the enders of the grade representing the specified level have been administered the tests, in others the beginners in the next higher grade were administered the tests. This had to be done to get a group which is available and which approximates the target population as closely as possible.

The pass percentage operating at the end of these levels might have affected the samples due to this strategy. It may, however, be pointed out here that the pass percentage at the primary and middle level is usually very high unlike that in the case of matriculation level. That is to say, most of the students in the V grade go to the VI grade and most of the students at the VIII grade pass and enter the IX grade. On the other hand

TABLE 7.5

Response Position of Schools in States

S.No.	*STATE*	*Level*	*No. of Schools participating in the Survey*	*Non-Response in percentage*	*Remarks*
1	2	3	4	5	6
1.	Andhra Pradesh	P	108	40%	More non-response in Telengana Region; Urban and Non-Govt. Schools
		M	103	43%	More non-response in Telengana & Circars regions, Urban & Non-Govt. Schools
		H	60	59%	More non-response in Telengana & Circars Regions
2.	Assam	P	40	33%	Equally spread over the variables
		M	34	43%	Equally spread over the variables
		H	29	38%	More in Urban & Govt. Schools
3.	Delhi	P	24	40%	More non-response in rural area
		M	32	30%	Equally spread over the variables
		H	28	22%	Equally spread over the variables
4.	Gujarat	P	92	17%	Equally spread over the variables
		M	93	5%	Equally spread over the variables
		H	66	28%	More in the Ahmedabad City
5.	Jammu & Kashmir	P	30	3%	Equally spread over the variables
		M	27	10%	Equally spread over the variables
		H	12	0%	
6.	Kerala	P	62	5%	Equally spread over the variables
		M	62	3%	Equally spread over the variables
		H	24	20%	More non-response in Central region & Govt. Schools

1	2	3	4	5	6
7.	Madhya Pradesh	P	131	13%	More non-response in Rewa region
		M	129	14%	Equally spread over the variables
		H	105	30%	More non-response in Bhopal & Mahakosal regions
8.	Maharashtra	P	190	5%	More non-response in Western Maharashtra region
		M	172	18%	More non-response in Bombay City
		H	110	26%	More non-response in Western Maharashtra region
9.	Mysore	P	127	17%	More non-response in Banglore and Mangalore regions
		M	134	10%	Equally spread over the variables
		H	104	31%	More non-response in Bangalore City and Dharwar region
10.	Orissa	P	85	11%	Equally spread over the variables
		M	85	10%	More non-response in Cuttack region and Non-Govt. Schools
		H	88	4%	More non-response in Non-Govt. Schools.
11.	Punjab	P	61	24%	More non-response in Urban Schools and Non-Govt. Schools
		M	61	24%	More non-response in Non-Govt. Schools
		H	40	50%	More non-response in Urban Schools and Non-Govt. Schools
12.	Haryana	P	30	9%	Equally spread over the variables
		M	26	21%	More non-response in Urban Schools and Non-Govt. Schools
		H	14	58%	More non-response in Non-Govt. Schools
13.	Rajasthan	P	90	12%	Equally spread over the variables
		M	92	9%	Equally spread over the variables
		H	70	31%	More non-response in Bikaner region, Rural Schools and Non-Govt. Schools
14.	Uttar Pradesh	P	133	26%	More non-response in Urban Schools and Non-Govt. Schools

1	2	3	4	5	6
		M	125	42%	More non-response in Non-Govt. Schools
		H	79	58%	More non-response in Urban Schools and Non-Govt. Schools
15.	West Bengal	P	45	68%	More non-response in districts other then Calcutta & Non-Govt. Schools
		M	58	59%	Equally spread over the variables
		H	35	75%	Equally spread over the variables
16.	Central Schools	P	46	17%	
		M	48	17%	
		H	41	29%	
17.	Public Schools	P	15	54%	More non-response from Public Schools other than Sainik Schools
		M	16	52%	More non-response from Public Schools other than Sainik Schools
		H	16	49%	More non-response from Public Schools other than Sainik Schools

at the matriculation level, the pass percentage is reduced to even 40% in some States.

In a few States, however, (like Punjab and Delhi) there is an external board examination at the end of middle level. In these States the impact of the selection ratio on sampling will be considerable. In all such cases at the middle and high school level the bias in sampling can be assumed to be in the direction of higher ability students getting into the sample.

Except in the case of Kerala, high school tests were conducted in grades equivalent to the matriculation level as near to the end of the educational year as possible. In Kerala, however, the high school tests had to be given to the beginners of the second year at college level. This was the only available group in the month of October/November which could be considered as having studied the syllabus prescribed for matriculation level. Not all students from High School i.e., 10th Grade go to colleges. This factor too, has biased the high school sample in Kerala in favour of better ability.

Because of these reasons it will not be proper to speak about the differences among States in quantitative terms. It will, however, be possible to look at these differences with a diagnostic approach and try to relate them with the varying systems of education existing in these States.

7.84 *Restrictions at the Analysis Stage:* It is mentioned above that all the students in a given section of selcted schools were administered the tests. It was proposed to score and analyse all the answer scripts received from the selected schools. But later a sub-sampling procedure had to be adopted for some states to meet the time targets of the project and to reduce costs. The procedure of sub-sampling followed was as described below:—

1. From each section/school 10 answer scripts were selected—5 for each froms (e.g. 5 for P I Test and 5 for P II Test at the Primary Level).
2. These answer scripts were selected in a systematic manner i.e., the first answer script was selected randomly out of the pile of form of the given level test from the section/school and the remaining four were then selected at a specific interval.

In other words all the schools who responded were in the sample but all the answer scripts from a given school were not analysed. This procedure of sub-sampling retained the inter-school variation even though the sample size was reduced considerably.

The sub-sampling for analysis purposes had to be done only in some States. Table 7.6 gives the names of States where sub-sampling was resorted.

To see if this sub-sampling procedure affected in any way estimating mean achievements and hence the interpretations, answer scripts of Kerala State at primary level were studied. The mean achievement for each school when sub-sampling was resorted to were compared with that when total number of scripts were analysed. Of the 62 schools included, significant

TABLE 7.6

States where Sub-sampling of Answer Scripts was Done

State	*Purpose & Levels*								
	Scoring Percentile norms			*Diff. Values*			*Item analysis*		
	P	M	H	P	M	H	P	M	H
1. A.P.	F	S	F	F	S				
2. Assam	S	S	F	S	S	F			
3. Delhi	F	F	F	SS	F	F	SS	F	F
4. Gujarat	F	S	S	F	SS	S		SS	
5. Jammu & Kashmir	S	S	F	S	S	F			
6. Kerala	F	S	F	SS	S	S	F	SS	
7. M.P.	S	S	F	S	S	F			
8. Maharashtra	F	F	S	SS	F	S	SS		
9. Mysore	F	S	S	SS	S	S	SS		
10. Orissa	S	F	F	S	SS	SS		SS	SS
11. Punjab	S	S	F	S	S	F			
12. Haryana	S	S	F	S	S	F			
13. Rajasthan	S	F	S	S	SS	S			
14. U.P.	S	S	S	S	S	S			
15. West Bengal	S	S	F	S	S	F			
16. Central Schools	S	S	S	S	S	S			
17. Public Schools	S	S	S	S	S	S			

F: Full data processed

S: Data sampled (Approximately 5 scripts from each school for each form)

S.S.: Schools sampled from the total schools for Item analysis. Same data used for other purposes.

Note; P M and H stand for Primary, Middle and High School Levels respectively

differences were observed only in 3 schools. The means when all the scripts are analysed and when sub-sampled scripts are taken up for each school are reported in Table 7.7.

TABLE 7.7

Means Calculated on Total Data and Sampled Data from Kerala Schools
(Form I—Primary Level)

	School code	*School Mean*	*Sub-sample Mean*
Region I (Southern)			
	13	22.48	20.60
	16	14.68	12.00
	17	25.36	28.80
	20	21.40	23.80
	25	22.20	20.80
	27	22.88	21.00
	29	18.20	13.80
	30	17.32	17.80
	31	18.28	17.20
	33	18.68	16.60
	35	18.84	21.20
	37	12.64	12.60
	38	19.28	22.80
	42	20.44	18.20
	43	20.00	20.60
	45	17.76	19.20
	48	20.24	21.60
	49	23.96	23.80
	50	18.96	16.60
	52	21.68	19.80
	53	20.32	20.40
	54	17.40	16.40
	55	27.40	26.40
	57	19.04	20.80
	60	17.84	11.40
	62	21.36	15.80
Region 2 (Central)			
	2	25.72	24.60
	3	25.16	20.80
	7	24.60	25.80
	8	17.95	15.60
	9	19.40	20.40
	11	17.76	18.40
	12	22.20	23.40
	14	22.28	26.40
	21	25.86	22.20
	22	25.48	25.40
	23	22.52	23.60
	24	19.48	18.40
	26	20.32	18.20
	32	20.80	16.80
	34	21.56	19.20
	39	23.48	21.60

	School code	*School Mean*	*Sub-sample Mean*
	40	22.20	19.40
	41	20.48	17.60
	44	25.60	26.20
	46	26.64	26.40
	51	21.60	24.80
	56	24.84	21.00
	58	28.29	30.40
	61	20.04	19.40
Region 3 (Northern)	1	21.16	20.80
	4	24.48	24.20
	5	27.08	26.00
	6	17.72	24.60
	10	22.68	23.60
	15	24.24	20.60
	*18	22.65	16.80
	19	21.48	18.80
	28	21.64	21.80
	47	22.48	23.60
	59	19.47	18.40

* Schools in which the sub-sample mean is significantly different (at 5%) from the school mean.

It was observed that there is no significant difference between these two procedures at the region and state level performance. On the strength of this finding it can be said that the sub-sampling has not affected the trend of results at stratification variables higher than schools. The mean of a given school however, might have been affected in a negative or positive direction. This factor has to be taken into consideration while interpreting the means obtained by a given school in the States where sub-sampling was adopted.

Because of the limitations and diversities discussed above, the difference between means obtained in various States indicating their performance are not compared statistically. It is, however, possible to see the general trends in different States and relate them to the different educational patterns prevailing in those States. The interpretations at the National Level, hence, will be more qualitative than quantitative, while at the State and regional level, more rigorous and quantitative implications could be derived.

At the high school stage another small reduction was forced on the sample due to use of separate answer sheets by students. Inspite of all instruction etc., some of the students failed to record on their answer sheet whether they took form I or II of the test. Many of such cases were identified through clues. e.g., returning an answer sheet with form I or II etc., but some answer sheets still remained without identification and such cases had to be omitted.

CHAPTER VIII

TEST CHARACTERISTICS

8.1 Organization of the Tests

8.11 *Purpose of the Test:* The tests were prepared primarily for use in a survey to assess the achievement of mathematics on the basis of which improvements could be suggested at the national and state level. Hence there was a certain normative character built into the project. The statistical characteristics of the tests discussed below are to some extent influenced by this normative character of the survey.

8.12 *Content.* The content areas included in the tests at different levels may not tally cent per cent with the syllabi prescribed by different States. But the content as suggested by the National Advisory Committee overlaps with the State syllabi to a large extent. There are some topics which the National Advisory Committee felt must be included in the test even if some States have not presently included them in their syllabi.

8.13 *Objectives.* There could be no two opinions regarding the desirability of the educational objectives as set forth by the National Advisory Committee. There may, however, be differences of opinion as to the specific weightage in terms of items allotted to a given objective. A consumer while using these tests shall have to decide for himself whether the tests represent the educational goals he wants to measure. In this exercise the tables of specifications would give him the necessary information.

8.14 *Equivalent Forms.* As finally evolved there are two equivalent forms of the tests at each level. Each form at the primary level contains 50 items, at middle level 70 items and at high school 80 items.

8.2 Validity of the Tests

8.21 *Content Validity.* Validity of an achievement test prepared for the survey purpose is to be measured primarily in terms of content validity. While reporting the validity of the ITED test, Lindquist observed that, "Content Validity is by far the most important aspect of the validity so far as achievement tests are concerned. It pertains to the nature of the skills used by examinees in answering the test questions and the appropriateness of these skills to the goals of education. By definition evaluation of content validity cannot be made by means of validity co-officients. The major contribution that test authors can make to the evaluation of content validity is to describe in as meaningful terms as possible, the nature of the skills that the test items were designed to assess. It remains for the test users, however, to judge the appropriateness of these skills to his instruction objectives. An informed judgement of this kind can be made only through a thorough painstaking examination of test materials and a reflective review of one's goals". (ITED Manual S.R.A. 1963).

8.22 *Predictive Validity.* As regards the predictive validity of the tests, no studies are so far undertaken. The real problem in designing such a study is that of finding an external criterion. Can one consider the Board examination marks as a criterion for the mathematics tests prepared in this survey? All the available researches conducted indicate that our examination system is highly unreliable and in many respects does not reflect the educational goals as stated in the syllabi or various other statements of the educators. Hence, it is of no use really to correlate the scores obtained on the Mathematics Achievement Test with scores obtained by the same student in the various Board examinations for validation purposes.

A separate study was, however, conducted just to see what is the correlation without claiming that the Board examination is the criterion. This study was conducted in Orissa, on a sample of 251 students of 9th grade, beginners drawn from 13 schools in different regions in Orissa. The marks obtained by these students in the previous Board examination (at the end of VII grade) were correlated with the marks obtained on Mathematics Achievement Tests. The correlation of .42 was found. This positive but low correlation was expected. The restricted range of the sample might have also contributed towards lowering the correlation. There was an overlap of content but not so much of objectives between these two tests. (Paikaray 1967).

It would be worthwhile, to study the correlation of scores on the Mathematics Achievement Test and the performance of students in the science colleges or the Indian Institutes of Technology or similar organisations where conceptual understanding of mathematics is an essential component for a successful performance. Such validation studies will be taken up later and will be reported in the supplement to follow this report.

8.3 Reliability of the Test

8.31 *Internal Consistency.* The internal consistency reliabilities of the tests at primary, middle and high school level respectively for different States participating in the survey are presented in Tables 8.1, 8.2 and 8.3. These tables provide sample size on which these reliabilities have been computed, means, standard deviation, standard error of measurement and indices of reliability.

It could be observed from Table 8.1 that the reliabilities at the primary level range from .71 to .88. Most of the reliability co-efficients however, are in the .80's. These are computed by Kuder-Richardson formula —21. For few States, reliabilities are also computed by KR—20 formula. As expected, application of the KR—20 increased the reliability co-efficients. The standard error of measurement for the primary level is around 3.

TABLE 8.1

Test Characteristics—Primary Level

State/Group	*Test*	*Sample Size* n	*Mean* m	*Standard Deviation* s.d.	*Internal Consistency Reliability*	*Standard Error of Measurement SEM*	*Index of Reliability*
1	2	3	4	5	6	7	8
1. Andhra Pradesh	P 1	2135	13.60	7.04	.8133	3.09	.9018
	P 2	2136	13.09	6.23	.7652	3.11	.8748
2. Assam	P 1	212	22.36	7.86	.8530	3.01	.9236
	P 2	205	23.43	8.53	.8124	3.69	.9013
3. Delhi	P 1	550	23.98	9.66	.8838	3.29	.9301
	P 2	589	24.09	8.96	.8628	3.32	.9289
4. Gujarat	P 1	1912	21.47	8.35	.8572	3.08	.9258
	P 2	1893	19.97	7.80	.8193	3.27	.3052
5. J & K (Urdu)	P 1	111	14.00	5.41	.6667	3.08	.8165
	P 2	109	14.67	6.28	.7520	3.07	.8672
(Hindi)	P 1	45	16.38	7.11	.8056	3.13	.8976
	P 2	45	16.31	7.13	.8076	3.06	.8986
6. Kerala	P 1	1531	21.36	6.63	.8007*	2.98	.8948
	P 2	1530	20.74	6.04	.7457	3.26	.8535
7. Madhya Pradesh	P 1	915	17.34	8.33	.8542	3.16	.9842
	P 2	911	15.73	7.36	.8173	3.09	.9040
8. Maharashtra	P 1	1233	19.97	8.03	.8481*	3.29	.9109
	P 2	1234	20.30	7.88	.8611	3.30	.9279
9. Mysore	P 1	2185	19.01	9.28	.8809	3.06	.9447
	P 2	2186	18.64	9.03	.8725	2.90	.9459
10. Orissa	P 1	435	22.11	7.94	.8925*	3.42	.9447
	P 2	438	22.19	7.72	.8748	3.47	.9306
11. Punjab	P 1	314	17.17	6.78	.7139	3.56	.8449
	P 2	316	17.21	6.32	.6808	3.53	.8251
12. Haryana	P 1	134	18.47	8.54	.8572	3.16	.9258
	P 2	134	17.36	8.53	.8197	3.58	.9045
13. Rajasthan	P 1	388	16.86	6.10	.7142	3.29	.8451
	P 2	393	16.38	6.61	.6546	3.19	.8091
14. Uttar Pradesh	P 1	1483	17.99	8.35	.8588	3.17	.9240
	P 2	1483	17.49	8.00	.8403	3.20	.9167
15. West Bengal	P 1	219	13.27	8.19	.8299	3.38	.9009
	P 2	221	21.26	6.98	.7639	3.39	.9740
16. Central Schools (Hindi)	P 1	137	17.44	7.17	.7970	3.28	.8927
	P 2	135	17.25	6.73	.7672	3.23	.8759
(English)	P 1	173	22.92	8.35	.8392	3.34	.9163
	P 2	159	22.21	7.89	.7829	3.35	.8848
17. Public Schools	P 1	70	25.27	7.95	.8182	3.34	.9045
	P 2	75	25.18	8.32	.8539	3.16	.9251

* KR-20 formula was used for these three States for calculating reliability coefficients while for others KR-21 formula was used.

TABLE 8.2

Test Characteristics—Middle Level

State/Group	*Test*	*Sample size* n	*Mean* m	*Standard Deviation* s.d.	*Internal Consistency Reliability*	*Standard Error of Measurement SEM*	*Index of Reliability*
1	2	3	4	5	6	7	8
1. Andhra Pradesh	M 1	513	12.60	5.02	.5896	3.18	.7745
	M 2	516	12.56	4.56	.5107	3.19	.7146
2. Assam	M 1	176	15.30	7.71	.8287	3.19	.9103
	M 2	176	16.67	8.31	.8104	3.62	.9002
3. Delhi	M 1	564	17.35	8.59	.8850	2.91	.9407
	M 2	557	17.98	9.13	.8519	3.51	.9230
4. Gujarat	M 1	482	17.23	7.27	.8047*	3.19	.8970
	M 2	471	16.98	5.78	.6564	3.41	.8004
5. J & K (Urdu)	M 1	91	12.49	7.50	.8290	3.10	.9005
	M 2	89	12.24	7.16	.8140	3.08	.9022
(Hindi)	M 1	45	14.18	5.08	.5690	3.35	.7543
	M 2	45	14.07	5.34	.6150	3.30	.7842
6. Kerala	M 1	306	16.48	6.24	.6602	3.57	.8125
	M 2	314	17.03	6.08	.6461	3.59	.8038
7. Madhya Pradesh	M 1	656	15.07	7.36	.7927	3.35	.8903
	M 2	637	14.62	6.28	.7111	3.34	.8433
8. Maharashtra	M 1	3086	17.36	8.22	.8183	3.50	.9046
	M 2	3064	16.50	9.79	.8032	3.46	.8962
9. Mysore	M 1	682	16.51	8.21	.8055	3.62	.8975
	M 2	657	15.94	8.45	.8389	3.39	.9159
10. Orissa	M 1	1421	19.89	8.23	.8515*	3.40	.9223
	M 2	1394	18.81	8.77	.8548	3.34	.9245
11. Punjab	M 1	315	17.26	7.58	.7919*	3.46	.8899
	M 2	314	16.11	7.41	.8305	3.34	.9113
12. Haryana	M 1	140	16.55	7.45	.8066*	2.28	.8982
	M 2	140	15.95	8.25	.8430	3.27	.9181
13. Rajasthan	M 1	1658	17.20	8.72	.8455*	3.23	.9196
	M 2	1652	16.07	6.72	.7528	3.68	.8776
14. Uttar Pradesh	M 1	619	16.44	7.80	.8037	3.46	.8965
	M 2	621	17.15	7.86	.8161	3.50	.9034
15. West Bengal	M 1	305	21.00	12.03	.9112	3.58	.9546
	M 2	270	20.17	11.24	.8921	3.69	.9440
16. Central Schools (Hindi)	M 1	79	14.58	6.19	.7664	2.93	.8754
	M 2	68	15.82	7.10	.7680	3.35	.8764
(English)	M 1	205	19.07	9.28	.8509	3.58	.9224
	M 2	168	18.75	8.02	.8038	3.55	.8965
17. Public Schools	M 1	80	28.30	11.02	.8737	3.92	.9347
	M 2	80	26.21	9.60	.8340	3.91	.9132

* In these States KR-20 formula was applied for calculating reliability coefficients and in the remaining KR-21 formula was applied.

TABLE 8.3

Test Characteristics—High School Level

State/Group	*Test*	*Sample size n*	*Mean m*	*Standard Deviation s.d*	*Internal Consistency Reliability*	*Standard Error of Measurement*	*Index of Reliability*
1	2	3	4	5	6	7	8
1. Andhra Pradesh	H1	696	18.05	7.34	.7604	3.67	.8662
	H2	723	19.32	7.66	.7596	3.76	.8716
2. Assam	H1	403	17.96	8.79	.8301	3.62	.9111
	H2	386	18.91	8.44	.8073	3.71	.8985
3. Delhi	H1	422	24.10	9.90	.8442*	3.87	.9188
	H2	436	23.76	9.42	.8250	3.97	.9083
4. Gujarat	H1	338	24.75	10.43	.8535	3.99	.9238
	H2	330	23.73	9.42	.8095	3.98	.8997
5. J & K (English)	H1	217	18.12	5.73	.5803	3.84	.7618
	H2	218	18.51	5.14	.4673	3.75	.6836
6. Kerala	H1	711	29.47	9.51	.8040	3.06	.8967
	H2	684	29.20	8.82	.7714	3.16	.8783
7. Madhya Pradesh	H1	1497	18.81	7.01	.7165	3.73	.8465
	H2	1399	19.84	8.51	.8041	3.77	.8967
8. Maharashtra	H1	1037	25.32	2.34	.8857	4.13	.9517
	H2	994	24.81	11.03	.8586	4.11	.9268
9. Mysore	H1	1208	16.23	6.18	.6429	3.69	.8018
	H2	1200	18.76	7.22	.7340	3.72	.8567
10. Orissa	H1	957	26.73	10.98	.8729*	4.06	.9290
	H2	953	26.86	10.65	.8676	4.08	.9237
11. Punjab	H1	617	19.27	7.64	.7588	3.76	.8711
	H2	619	21.35	7.18	.7050	3.90	.8396
12. Haryana	H1	200	20.56	7.40	.7301	3.84	.8545
	H2	195	22.92	7.63	.7281	3.16	.8533
13. Rajasthan	H1	353	19.89	7.64	.7235	3.79	.8690
	H2	347	20.53	6.75	.6736	3.86	.8207
14. Uttar Pradesh	H1	444	17.64	8.58	.8235	3.60	.9075
	H2	429	19.36	8.63	.8130	3.73	.9017
15. West Bengal	H1	508	26.56	12.46	.8970	4.00	.9471
	H2	484	26.12	12.71	.9024	3.97	.9499
16. Central Schools (Hindi)	H1	111	17.04	5.91	.6238	3.62	.7890
	H2	115	18.13	6.32	.6571	3.70	.8106
(English)	H1	310	20.03	9.13	.8302	3.66	.9112
	H2	347	21.94	9.49	.8336	3.87	.9130
17. Public Schools	H1	82	31.37	13.84	.9171*	4.12	.9576
	H2	77	31.71	10.99	.8649	4.23	.9300

* In these States KR-20 formula was used for calculating reliability coefficients while in other States KR—21 was used.

At the middle level, the reliability co-efficients range from .88 to .87. However, for some States the mean score obtained is below the guess score and as such the reliabilities have gone down even up to .51 (Refer to Table 8.2). The standard error of measurement at this level is around 3.

At the high school level, the reliabilities range from .72 to .98. Here, too, in States where the mean score is below guess score, the reliability co-efficients have gone down as low as .46 (Refer to Table 8.3). The standard errors of measurement at this level range from 1.25 to 4.23. But in most of the States, it is around 3 as is the case at the primary level.

8.32 *Reliabilities of Other Achievement Tests.* These reliability co-efficients compare favourably with those reported for the STEP series as well as for the IOWA Test of Basic Skills. The reliabilites of the mathematics tests in the STEP series are in .80's. The reported reliabilities of the IOWA Test of Basic Skills range from .74 to .90. The standard error of measurement of mathematics tests in the STEP series are little over 3 with tests of 50 items. The standard error of IOWA Tests of Basic Skills range from 1.65 to 3.05. Most of them, however, are above 2. (For details refer to Chapter II).

One of the limitations on the tests used in this survey was their criterion-referenced nature. Because of this, the tests proved to be difficult and positively skewed distribution of scores are obtained in all the States and even in the special categories of schools, i.e. Central Schools and Public Schools. At the middle and high school level the means obtained in quite a few States are below guess score. The difficulty of tests have lowered the reliability co-efficients. When the reliability co-efficients of the tests presented in Tables 8.1, 8.2 and 8.3 are read in the context of these limitations, one can interpret them as quite satisfactory.

8.33 *Equivalent Form Reliability.* The equivalent nature of the tests was investigated in various ways. The traditional way to study an alternative form reliability is to administer both the forms to the same students. It was administratively not practicable to conduct a very large scale study by administering both the forms to the same students. Hence, a small study was taken up in Delhi to study the alternate form reliability in the traditional design. Table 8.4 provides the realiability co-efficients computed on those data.

TABLE 8.4

Parallel Form Reliability Co-efficient for Three Levels

Level	*N*	*Mean*	*S..*	*Reliability*
Primary Level	162	P1 =21.72	6.98	.64
(50 items)		P2 =21.43	6.35	
Middle Level	111	M1 =22.67	12.7	.84
(70 items)		M2 =25.04	13.7	
High School Level	53	H1 =31.26	11.14	.89
(80 items)		H2 =30.93	12.33	

The reliability at the middle and high school level could be considered as satisfactory while at the primary level it has raised certain questions. Investigations revealed that the second form of the test was administered in different schools on the same day. It is felt that students might have got bored and might not have exerted themselves uniformly on both these forms. This might have given rise to chance variation reducing the alternate form reliability co-efficient.

8.34 *Intra-class Correlation Coefficients.* Another way of styding the equivalence was to compute intra-class correlation between two groups in a set of schools. As noted in Chapter VII, both the forms of these tests were administered in the same section of different schools by splitting the sections randomly into two groups. Hence, it can be assumed that if the forms are equivalent, the mean score obtained by the 2 groups in a given section of a given school should more or less be the same. The intra-class correlations computed on the data from some States are presented in Table 8.5.

TABLE 8.5

Equivalent Form Reliability

Intra-Class Correlations Coefficient

Level/State	*Primary*	*Middle*	*High*
Delhi	0.83 (18)	0.83 (10)	0.86 (19)
Kerala	0.92 (65)	S	0.61 (24)
Maharashtra	0.75 (190)	0.78 (120)	S
Orissa	S	0.88 (102)	0.69 (88)

N.B.: Figures in the brackets denote the number of schools over which the intra-class correlations coefficient was calculated.

S: denote that sub-sampling procedure was adopted and as such intra-class correlations coefficient not calculated.

Considering the fact that a correlation coefficient in this procedure is affected by the school variations, these correlations are a satisfactory index of equivalence.

8.4 Item Analysis

8.41 *Difficulty and Discriminating Indices.* Tables giving difficulty values and discrimination values for one State both at the try-out and final survey stage are provided in Appendix 8.1 These indicate that items were discriminating among students fairly satisfactorily. A traditional achievement test strives to get average difficulty around 50. But as the tests for this survey were criterion referenced, no attempt was made at the test construction stage to manipulate the values to get average difficulty around 50. The mean difficulty value varies from State to State and from level to level. Their distribution in practically all the States is positively skewed.

8.42 ***Distractor Analysis.*** As stated in Chapter IV, distractors used in each item were mostly based on the previous studies regarding misconceptions and errors committed by students. A study of students responses to such distractors hence could be made for diagnostic purposes. Frequencies of such errors (choosing a particular distractor) could also reflect the magnitude of certain misunderstandings. A separate study on these lines was conducted on the primary and middle level data from Rajasthan State (Ishwar Chandra, 1967).

Table 8.6 lists the kinds of errors and their frequencies for the topic of Fractions and Decimals. Similarly other topics could be analysed and their error patterns could be studied. A teacher may analyse the distractors on these lines and develop his remedial measures —the next lesson or assignment for dispelling the misunderstandings.

TABLE 8.6

Type of Misconceptions, Related Distractors, Questions, Difficulty Value and Percentage Frequency

Topic:- Fractions & Decimals at Primary Level.

Type of Misconception Knowledge	*Related Distractors*	*Difficulty value of*	*Percentage*
1	2	3	4
Practions and Decimals			
1. Lack of comprehension of value	18 P1 (A.D.)	13.1	75.3
	20 P2 (B, C)	13.0	72.3
2. Lack of fundamental	18 P1 (C)	13.1	3.3
	20 P2 (D)	13.0	4.3
Skill			
1. Misplacing decimal point	20 P1 (A, D,)	36.6	19.8
	21 P1 (A, C, D)	38.3	55.5
	24 P2 (C. D)	41.7	14.3
2. Failure to reduce remainder to decimal	20 P1 (C)	36.6	30.3
3. Inability to write decimal as fraction	22 P1		
	25 P2 (A, B, C)	17.5	72.2
	(A)	17.1	16.8
4. Decimal point omitted	23 P2 (A)	32.0	29.2

1	2	3	4
5. Failure to prefix zero in quotient	23 P2 (B)	32.0	16.5
6. Prefixing unnecessary zero	24 P2 (A)	41.7	35.3
7. Extra zeros in quotient	23 P2 (D)	32.0	14.1
8. Using extra zeros while writing fraction as decimal	25 P2 (B)	17.1	9.5
9. While converting decimal into fraction omits decimal and takes its reverse (.5 — 1/5)	25 P2 (C)	17.1	45.8
10. Lack of comprehension of process			
(a) Substracts whole number in dividend from divisor disregarding fraction (3¾ kilogram = 5—2¾ kg)	29 P2 (B)	60.6	7.8
(b) Multiplies only in whole numbers (5×3¾ —15¾)	29 P2 (C)	60.6	17.9
11. Wrong operation			
(a) Divides instead of multiplying	25 P1 (A.B.) 29 P1 (C)	26.0 30.3	42.1 22.6
(b) Adds instead of multiplying	25 P1 (D)	26.0	23.4
Application			
1. Lack of comprehension of process.			
(a) In adding two fractions multiplies numerators for the numerator in the sum and multiplies denominators for the denominator	23 P1 (A)	15.9	42.9
(b) Subtracts numerators and takes one of the denominators for the demoninator in the sum	23 P1 (A)	15.9	24.1
(c) Substracts numerators and takes the common denominator for the denominator in the sum.	23 P1 (C)	15.9	11.3
2. Difficulty in understanding the problem remaining portion means the portion that is worked out.	24 P1 (A.C) 27 P2 (A.B)	36.2 17.6	23.6 25.6
3. Misplacing decimal point	24 P1 (B)	36.2	31.1
4. Wrong process:			
(a) Multiplies two quantities instead of adding these two and subracting from one (whole part)	26 P1 (A)	63.8	8.2
(b) Substracts the one from the other instead of adding them and substracting from one (whole part)	26 P1 (C)	63.8	13.8
(c) Multiplies instead of adding	26 P1 (D)	63.8	7.1
(d) Uses a number convenient to the pupil disregarding the given one	27 P1 (A)	28.8	13.8

1	2	3	4
(e) Takes one paise daily means one rupee per month	27 P1 (D)	28.8	12.3
(f) Disregards percentage symbol (5% means 50)	27 P1 (C)	28.8	38.3
(g) Takes total + total + parts of total (If total 50 papers—30 red papers and 20 white papers, uses total —50+30+20=100 papers).	27 P2 (D)	17.6	49.1
5. Lack of fundamental knowledge in Fraction and Decimals.	28 P2 (A.C)	44.0	36.0
6. In solving problems containing decimals			
(a) Misplaces decimal point	31 P2 (B)	51.9	3.3
(b) Omits decimal point	31 P2 (C)	51.9	34.8
(c) Uses extra zeros (.4=04)	28 P2 (D)	44.0	11.3
(d) While multiplying two numbers puts them togther (30×5=305)	31 P2 (D)	51.0	4.6
Logical Reasoning			
1. Difficulty in reducing fractions to lowest terms—does not reduce	19 P1 (A.C)	23.9	41.9
2. Falls to find equivalent fraction	19 P1 (B)	23.9	21.8
3. Wrong operation			
(a) Takes that smallest fraction which possesses least denominator	21 P2 (A)	25.3	59.3
(b) Takes that smallest fraction which possesses largest numerator	21 P2 (C)	25.3	9.0
4. Lack of comprehension of process			
(a) In dividing a whole number by fraction which does not divide, takes whole number itself as answer	30 P2 (A)	21.7	35.8
(b) In dividing a whole number by a fraction, adds the denominator of the fraction to the whole number	30 P2 (B)	21.7	20.2

8.5 Norms

The percentile norms for all the States and within a State by regions and sectors are computed. These are provided for all the States in the "Teachers' Manual". It is always desirable, however, that local agencies develop norms for smaller groups/communities like block, town, etc.

8.6 Testing Procedure

8.61 *Administration:* The procedure of administering these tests is very simple. A trained Counsellor or an expert test administrator is not necessary to administer these tests. A local teacher can also administer these tests. The directions on how to solve multiple choice items and some practice items are provided in the booklet entitled "Directions and Questions for Practice." A teacher should read these directions along with the students and after ensuring that the students have worked on the practice items, administer the tests in the manner he conducts regular class examinations.

8.62 *Time.* Although in the try-out there was no fixed time, at the survey stage the time was fixed on the basis of the information provided in the try-out stage. The time for the test was fixed as follows:-

Primary level tests	2.30 hours
Middle & High school level tests	3.00 hours

There was no report indicating this time limit as stringent. Hence, it could be said that in future this time limit may be followed. It may be emphasised, however, that essentially the tests are power tests and, therefore, the time limit may not be rigorously imposed on any particular group. A rule of thumb that an invigilator may ask the students to stop after about 90% students finish a test is a good rule to follow for these power tests.

8.63 *Scoring Procedure.* The tests being multiple choice objective type tests, the scoring procedure is very easy. Any person who can add and substract can score these tests with the help of the scoring key. A teacher who wants to discuss the restults of the tests immediately after its use in the class room can do so as he can quickly score the tests or can even ask students to do it on his behalf. Scoring keys for all these tests are given at Appendix 8.2.

CHAPTER IX

MATHEMATICS ACHIEVEMENT—GEOGRAPHICAL VARIABLES

9.1 States—Mathematics Achievement

9.11 *General Performance.* The mean scores (expressed in percentages) on MAS tests obtained by the different states and the special categories of schools are given in Table 9.1 for primary, middle and high school levels. For various reasons explained in the earlier chapter regarding the diversities in educational systems followed by different states, one should not compare them on the basis of their performance or rank them in order of merit. Rather one should examine the performance of different groups of schools within a state and locate the reasons for differences if any, and take up the necessary measures to bring the different groups (within a state) to a higher—desired level of performance. In this chapter the performance at state level, regional differences and urban rural difference within a state will be considered with this orientation. Other variables will be taken up in the subsequent chapters.

One way of looking at the results given in Table 9.1 is to locate those States which have obtained at least 35% marks as their mean achievement. Only the Public Schools got more than 35% achievement at all the three levels of education. The details regarding the performance of the states at primary, middle and high school levels are given in the sections 9.21, 9.22 and 9.23 respectively. In these sections tables of average difficulty values for content dimension as well as objective dimension were given followed by detailed discussion. These average difficulty values of topic/objective indicate the average of the difficulty values of items belonging to that topic/objective (wherein difficulty value of an item indicate the percentage of students getting that item correct). Here one may frame the rule that if a topic gets an average value of 30 or below, that topic needs more careful treatment as 70 per cent or more students have not mastered the topic. Such a decision rule may change under improved conditions of teaching. A stage may reach where a teacher might expect that more than 50 per cent or 80 per cent of his students should master a particular topic and solve items correctly. For the present, even if one sticks to a very low expectations of 30 per cent decision rule one finds a long list of topics which our students are finding difficult.

9.12 *Primary Level Performance.* At primary level most of the States secured more than 35% marks and none less than the guess score (which is

TABLE 9.1

Sample Size n and Mean Score in Percentage in Different States and at Different Levels

State		*Primary Level*		*Middle Level*		*High Level*	
		n	*Mean*	*n*	*Mean*	*n*	*Mean*
1	2	3	4	5	6	7	8
1. Andhra Pradesh	Form 1	2135	26%	513	18%	606	23%
	Form 2	2136	26%	516	18%	723	24%
2. Assam	Form 1	212	41%	176	22%	403	22%
	Form 2	205	47%	176	24%	386	23%
3. Delhi	Form 1	550	48%	564	25%	422	30%
	Form 2	589	48%	557	26%	436	30%
4. Gujarat	Form 1	1912	42%	482	25%	338	31%
	Form 2	1828	40%	471	24%	330	30%
5. Jammu & Kashmir (Hindi)	Form 1	45	33%	136	20%		
	Form 2	45	33%	134	20%		
(Urdu)	Form 1	111	28%	91	18%	217*	23%
	Form 2	109	29%	89	17%	218*	23%
6. Kerala	Form 1	1531	43%	306	24%	711	37%
	Form 2	1530	41%	306	23%	684	37%
7. Madhya Pradesh	Form 1	915	36%	656	22%	1497	24%
	Form 2	911	33%	637	21%	1399	25%
8. Maharashtra	Form 1	1233	40%	3084	25%	1037	32%
	Form 2	1234	41%	3064	24%	994	31%
9. Mysore	Form 1	2186	38%	682	24%	1208	23%
	Form 2	2185	37%	657	23%	1200	23%
10. Orissa	Form 1	435	44%	1421	28%	957	33%
	Form 2	438	42%	1394	27%	953	34%
11. Punjab	Form 1	314	34%	315	25%	617	24%
	Form 2	316	34%	314	23%	619	26%
12. Haryana	Form 1	134	37%	140	24%	200	26%
	Form 2	134	35%	140	23%	195	28%
13. Rajasthan	Form 1	388	34%	1658	24%	353	22%
	Form 2	393	33%	1652	23%	347	24%
14. Uttar Pradesh	Form 1	1483	36%	619	23%	444	22%
	Form 2	1483	35%	621	24%	429	24%
15. West Bengal	Form 1	219	46%	305	30%	508	33%
	Form 2	221	42%	270	29%	484	33%
16. Central Schools (English)	Form 1	173	46%	205	27%	301	25%
	Form 2	159	44%	168	27%	347	27%
(Hindi)	Form 1	137	35%	79	21%	111	21%
	Form 2	135	35%	68	22%	115	23%
17. Public Schools	Form 1	70	51%	80	40%	82	39%
	Form 2	75	50%	80	38%	77	40%

*Tests in English were administered in Jammu & Kashmir at High School Level

TABLE 9.2

Average Difficulty Values of Topics at Primary Level

S. No.	State	Numeration & Four Fundamental Operations	Units	Fractions & Decimals	Factors & Products	Family Budget	Simple Proprtions	Percentage & Simple Interest	Profit & Loss	Estimation	Geometry	Integrated
1.	Andhra Pradesh	37	25	25	25	26	21	17	22	36	25	29
2.	Assam	52	50	41	44	62	42	19	39	50	62	33
3.	Delhi	62	44	38	80	43	35	20	34	47	46	30
4.	Gujarat	51	38	36	50	43	36	20	31	61	50	41
5.	Jammu & Kashmir (Hindi)	44	32	35	46	31	30	17	28	36	36	27
6.	Jammu & Kashmir (Urdu)	48	28	28	55	19	18	13	19	23	16	19
7.	Kerala	55	46	42	40	50	37	13	36	63	57	44
8.	Madhya Pradesh	47	35	31	48	33	29	18	30	38	33	27
9.	Maharashtra	54	39	34	47	38	35	19	36	61	52	40
10.	Mysore	48	41	40	32	38	26	23	33	43	43	30
11.	Orissa	67	46	36	55	44	49	18	34	42	46	26
12.	Punjab	54	34	34	47	38	35	19	36	61	52	40
13.	Haryana	53	37	32	53	39	32	23	30	40	40	27
14.	Rajasthan	49	38	31	32	38	30	16	28	46	37	30
15.	Uttar Pradesh	44	38	37	37	32	33	17	33	45	32	30
16.	West Bengal	65	50	36	48	57	46	18	35	34	58	25
17.	Central Schools (English)	60	46	45	39	51	46	21	35	50	57	33
18.	Central Schools (Hindi)	47	37	31	50	36	33	14	31	44	43	31
19.	Public Schools	62	53	47	53	62	52	22	37	55	69	33

25% in the case of multiple choice test with four alternatives). The average difficulty values of different topics for different States/special categories of schools are reported in Table 9.2. Similar information in respect of objectives of teaching mathematics appears in Table 9.3.

TABLE 9.3

Average Difficulty Values of Different Objectives in different States at Primary Level

State/Group	*OBJECTIVES*			
	Knowledge	*Skill*	*Application*	*Logical Reasoning*
1. Andhra Pradesh	25	36	24	25
2. Assam	48	59	40	52
3. Delhi	59	58	35	39
4. Gujarat	41	55	32	43
5. Jammu & Kashmir (Hindi)	38	45	30	30
6. Jammu & Kashmir (Urdu)	38	42	23	26
7. Kerala	48	57	35	45
8. Madhya Pradesh	38	48	29	30
9. Maharashtra	45	48	33	39
10. Mysore	40	53	34	35
11. Orissa	50	53	37	43
12. Punjab	24	52	27	38
13. Haryana	42	51	31	34
14. Public Schools	60	60	43	48
15. Rajasthan	38	49	30	31
16. Uttar Pradesh	38	48	32	30
17. West Bengal	36	61	36	43
18. Central Schools (English)	45	64	38	44
19. Central Schools (Hindi)	42	48	29	33

Under the decision rule (of 30 per cent difficulty value) Percentage and Simple Interest seem to be the most difficult, followed by Profit and Loss, Fractions and Decimals and Integrated Problems. Further the content areas covering Simple Proportion, Family Budget and Units are also giving some trouble to many of our students. Numeration and Estimation seem to be less difficult.

On the objective dimension (Table 9.3) items involving application of concepts are proving difficult. Similar is the case with items that involve more of reasoning rather than rote knowledge. In most of the States items on the objectives Application and Logical Reasoning are comparatively difficult than those on the objectives Knowedge and Skill. Comparing the average difficulty values of the objectives one may rank them also. Most difficult objective seems to be Application, followed by Logical Reasoning, Knowledge and Skill. **This trend appears in most of the States.**

9.13 *Middle Level Performance.* At the middle level only Public Schools scored more than 35% while all other States/groups of schools are below this attainment level. Only Delhi, Gujarat, Maharashtra, Orissa, West Bengal and Central Schools got their means more than the guess score. Compared to the performance at the primary level, the middle level performance is poor. One explanation for this poor performance might be that students in some of these States could not respond to Algebra items as Algebra is generally introduced only at high school stage in these States.

But, as the table of difficulty values for topics (Table 9.4) indicate, the performance on Arithmetic and Geometry items is also much below the expectations.

The specific topics that could be considered as difficult under the decision rule (of 30 per cent difficulty value) are listed below:

1. Average
2. Percentage of Profit & Loss
3. Speed
4. Average and Value
5. Laws and Assumptions
6. Simple Equations and Problems
7. Simultaneous Equations
8. Formuale
9. Graphs

Further the content areas covering Number; Graphs of Statistics; Triangles, Quadrilaterals and Circles and Intergrated problems also seem to be difficult to our students.

On the objective dimension (Table 9.5) items involving Skill, Application Reasoning are found to be more difficult than the items involving Knowledge. Comparing the average difficulty values items on Application objective seem to be most difficult followed by items on Logical Reasoning and Skill, while items on Knowledge objective seem to be relatively easier. This trend appears in most of the States.

9.14 *High School Level Performance.* As compared to the middle level, the situation improves at the high school level but not to a very satisfactory level. Only Public Schools and Kerala have got more than 35% score.

The mean score obtained by the States of Delhi, Gujarat, Maharashtra, Orissa, Haryana, Punjab, Madhya Pradesh, West Bengal and the Central Schools (English medium) touch or cross the guess score.

It may be mentioned here that in all these States the percentage performance is higher at the primary level than at the middle or high school levels. However, the high school performance is slightly better than at the middle. One of the reasons is diversification of courses and the selectivity factor which results in many drop-outs after the middle school level. It may be mentioned here that in the sample selected for the high school level

TABLE 9.4.

Average Difficulty Values of Topics at Middle Level

S. No. State	*Number*	*Average*	*Percentage & Profit and loss*	*Simple and Compound Interest*	*Ratio & Proportion*	*Speed*	*Average Volume*	*Graphs of Statistics*	*Symbolic Representation*	*Four Fundamental Operations*	*Law and Assumption*	*SimpleEquations & Problems*	*Simultaneous Equations & Problems*	*Formulae*	*Graphs*	*Solids*	*Lines*	*Angles*	*Triangles Quad. & Circles*	*Integrated*
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Andhra Pradesh	13	15	10	19	25	9	23	17	21	17	24	13	13	14	11	33	33	16	21	16
2. Assam	23	13	13	21	20	16	23	16	27	32	27	17	9	18	10	22	59	30	28	18
3' Central School (English)	25	15	15	35	26	18	25	26	38	34	24	22	16	17	18	36	47	39	27	23
4. Central School (Hindi)	18	12	9	26	19	15	24	21	27	24	22	18	19	11	15	25	43	29	28	25
5. Delhi	21	13	11	41	34	16	27	17	28	24	28	19	30	17	16	38	40	26	24	21
6. Gujarat	26	15	14	32	20	15	24	26	32	23	28	18	14	17	15	39	39	37	28	22
7. Jammu & Kashmir (Hindi)	17	13	13	23	28	21	22	16	24	23	26	16	13	14	9	19	34	22	24	19
8. Jammu & Kashmir (Urdu)	19	17	16	27	29	10	22	12	16	19	17	11	7	15	14	22	19	19	16	12
9. Kerala	18	19	15	43	22	17	25	22	36	18	23	18	9	16	18	46	41	25	28	23
10. Madhya Pradesh	19	12	13	32	18	15	24	18	28	24	25	17	9	15	18	6	28	40	22	23
11. Maharashtra	19	14	15	25	13	14	23	22	33	24	28	19	10	13	15	45	46	23	27	22
12. Mysore	19	15	17	18	26	20	22	23	28	34	28	17	15	21	17	53	40	22	25	20
13. Orissa	27	20	22	35	28	29	30	21	35	30	24	27	10	24	14	30	48	45	30	28
14. Punjab	23	13	17	39	41	16	26	15	32	28	23	18	7	14	13	22	39	28	25	20
15. Haryana	20	15	18	38	39	18	24	15	29	29	23	17	9	18	19	21	37	22	25	20
16. Public Schools	40	28	22	41	36	31	36	48	54	48	24	40	21	21	23	54	64	59	39	27
17. Rajasthan	20	22	13	26	30	16	24	22	27	27	22	17	8	13	14	27	40	22	23	18
18. Uttar Pradesh	24	14	17	20	25	16	27	18	32	27	26	20	28	13	17	29	45	28	28	18
19. West Bengal	27	23	15	24	21	22	31	23	38	51	26	28	13	25	15	38	41	46	36	28

TABLE 9.5

Average Difficulty Values of Different Objectives in States at Middle Level

State/Group	*OBJECTIVES*			
	Knowledge	*Skill*	*Application*	*Logical Reasoning*
1. Andhra Pradesh	24	15	18	18
2. Assam	32	31	18	24
3. Delhi	31	23	21	22
4. Gujarat	37	23	20	24
5. Jammu & Kashmir (Hindi)	26	19	19	19
6. Jammu & Kashmir (Urdu)	25	18	17	15
7. Kerala	35	20	22	24
8. Madhya Pradesh	31	21	19	20
9. Maharashtra	37	23	21	23
10. Msyore	34	21	21	21
11. Orissa	39	28	26	27
12. Punjab	34	22	24	22
13. Haryana	29	23	24	21
14. Public Schools	51	41	77	41
15. Rajasthan	28	23	21	20
16. Uttar Pradesh	34	24	21	23
17. West Bengal	38	34	23	28
18. Central Schools (English)	39	27	22	27
19. Central Schools (Hindi)	29	20	18	25

both the higher and lower level mathematics groups were represented in most of the states. The sample constituted both the science and humanities groups. But the weightages of the different streams and that of the higher and lower mathematics group are different from state to state. However in most of the states the samples are slightly biased towards better ability groups. Even then at the national level the performance at the high school level is far from satisfactory.

The average difficulty values at different topics for different states/ special categories of schools is given in Table 9.6. Similar information in respect of objectives of teaching mathematics appears in Table 9.7.

As regards the content there is no one topic which could be considered as easy at the national level. Under the decision rule of 30 per cent difficulty value, one finds a long list of topics which our students are finding difficult. These topics are:

1. Ratio and Proportion
2. Interest, Present-worth and Discount Stocks and Shares, Exchanges
3. Area and Volume

TABLE 9.6

Average Difficulty Values of Topics at High School Level

S. No. State	*Sq. root & Cube root*	*Ratio & Proportion*	*Interest, Present-worth etc.*	*Area & Volume*	*Algebraic Law & Four Fundamental Operations*	*Product & Factor*	*Functions*	*Simple Simultaneous Equations.*	*Graphs*	*Quadratic eqns.*	*Ratio & Proportion*	*Elimination*	*Surds*	*A.P. & G.P.*	*Logarithms*	*Angles at a point*	*Parallel Lines*	*Triangles & their Properties*	*Polygons and Parallelograms*	*Areas*	*Loci*	*Circles and Tangents*	*Trigonometry*	*Integrated*
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1. Andhra Pradesh	30	25	20	18	20	33	26	24	27	22	20	18	20	32	10	23	20	25	28	22	19	27	22	20
2. Assam	35	21	17	17	33	50	24	20	27	17	15	15	27	40	14	28	19	23	18	16	20	23	28	20
3. Delhi	43	34	32	21	25	45	24	27	20	26	19	23	28	44	24	37	30	29	34	24	23	35	19	29
4. Gujarat	45	32	38	23	31	53	34	28	27	27	25	23	30	35	25	32	29	30	39	22	23	20	19	26
5. Jammu & Kashmir	42	25	19	19	32	42	24	18	16	17	19	23	21	27	18	29	22	22	20	16	16	20	28	21
6. Kerala	50	41	22	30	40	47	54	35	53	33	25	35	38	65	46	41	33	33	26	28	29	23	46	31
7. Madhya Pradesh	34	25	26	19	22	34	29	20	18	17	22	18	23	34	14	26	25	24	22	21	22	26	21	23
8. Maharashtra	43	34	32	22	25	45	24	27	19	29	19	23	28	44	24	38	31	30	34	24	23	45	19	29
9. Mysore	28	25	24	21	21	38	28	23	19	19	21	19	24	34	11	28	23	23	30	20	20	29	15	23
10. Orissa	30	47	18	28	31	55	27	33	21	27	19	19	35	43	6	41	39	41	42	39	20	37	40	32
11. Punjab	39	32	30	20	30	43	22	22	22	13	23	28	22	10	10	40	26	30	14	14	22	24	15	24
12. Haryana	40	37	33	17	32	45	26	21	20	18	20	21	24	41	12	28	20	27	32	23	22	32	22	26
13. Rajasthan	38	32	23	21	23	40	24	24	26	21	23	21	23	41	12	39	25	25	28	24	22	28	24	25
14. Uttar Pradesh	34	30	22	19	20	32	21	22	18	18	20	18	23	32	13	34	30	26	27	22	20	26	17	22
15. West Bengal	48	34	20	25	48	62	26	28	40	33	26	34	42	57	29	29	33	26	26	20	24	29	43	29
16. Central School (English)	47	26	22	21	28	40	30	23	23	20	19	23	26	46	17	34	30	27	23	21	16	23	28	26
17. Central Schools (Hindi)	28	20	24	13	21	32	21	20	21	19	21	16	16	34	13	25	24	28	21	19	22	22	28	23
18. Public Schools	63	44	27	30	41	43	34	34	52	33	24	33	33	68	37	49	44	43	25	30	18	43	39	35

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4. Algebraic Laws and Four Fundamental Operations
5. Functions
6. Simple and Simultaneous Equations and Problems
7. Graphs
8. Quadratic Equations
9. Ratio and Proportion
10. Elimination
11. Surds
12. Logarithms
13. Parallel Lines
14. Triangles and their Properties
15. Polygons and Parallelograms
16. Areas
17. Loci
18. Trignometry
19. Integrated Problems

TABLE 9.7

Average Difficulty Values of Different Objectives in States at High School Level

State/Group	*OBJECTIVES*			
	Knowledge	*Skill*	*Application*	*Logical Reasoning*
1. Andhra Pradesh	23	25	23	21
2. Assam	22	30	20	21
3. Delhi	26	32	29	26
4. Gujarat	30	35	29	26
5. Jammu & Kashmir	24	29	21	20
6. Kerala	38	44	35	31
7. Madhya Pradesh	22	25	23	22
8. Maharashtra	28	32	29	26
9. Mysore	20	26	24	21
10. Orissa	29	36	35	32
11. Punjab	24	31	25	21
12. Haryana	26	31	27	23
13. Public Schools	35	46	21	38
14. Rajasthan	24	29	26	27
15. Uttar Pradesh	21	24	25	21
16. West Bengal	34	45	29	26
17. Central Schools (English)	25	31	24	25
18. Central Schools (Hindi)	23	24	21	21

On the objective dimension (Table 9.7) items on the objective Skill are compariatively easier, while the items on the objective Logical Reasoning are difficult. As the difficulty values indicate there is no definite trend regarding the items on objectives, Knowledge and Application. This trend appears in a majority of the States.

9.15 *General Discussion.* In the earlier sections it was pointed out that the performance of students is much below the expectations even for the items belonging to topics in Arithmetic and Geometry—even though these were covered in the earlier grades. To study this a separate study was conducted in a school in Delhi wherein primary level tests were administered to VI, VII and VIII grades while middle level tests were administered to IX, X and XIth grade students. Both the parallel forms were administered to these students. The sample size consists of 39, 36 and 34 students for the grades VI, VII and VIII respectively for primary level tests and 32 students each for grades IX, X and XI. Table 9.8 gives the average difficulty values for different topics and Table 9.9 for different objectives of the primary level tests for the three grades VI, VII and VIII. Similarly, Tables 9.10 and 9.11 give the average difficulty values for different topics and objectives respectively of middle level tests for the three grades IX, X and XI.

TABLE 9.8

Average Difficulty Values of the Topics of the Primary Level Tests for VI, VII & VIII Grades

S. No.	*Content*	*GRADE*		
		VI	*VII*	*VIII*
1.	Numeration & Four Fundamental Operations	28.5	28.6	33.8
2.	Units	21.0	20.8	24.9
3.	Fractions & Decimals	19.1	17.8	23.1
4.	Factors & Products	28.2	28.5	25.0
5.	Family Budget	18.7	27.8	34.4
6.	Simple Proportion	15.4	18.1	26.5
7.	Percentage & Simple Interest	9.6	9.0	1
8.	Profit & Loss	11.5	19.0	21.1
9.	Estimation	25.6	36.1	42.6
10.	Geometry	24.8	30.6	37.4
11.	Integrated	5.1	1.4	0.0

TABLE 9.9

Average Difficulty Values of the Objectives of the Primary Level Tests for VI, VII & VIII Grades

		GRADE		
S. No.	*Objective*	*VI*	*VII*	*VIII*
1.	Knowledge	25.6	24.2	28.2
2.	Skill	28.2	28.9	33.2
3.	Application	16.3	17.0	23.2
4.	Logical Reasoning	17.4	22.2	27.6

TABLE 9.10.

Average Difficulty Values of the Topics of the Middle Level Tests for IX, X & XI Grades

S. No.	*Content*	GRADE		
		IX	*X*	*XI*
1.	Numbers	14.8	18.8	22.4
2.	Average	2.0	3.0	10.2
3.	Percentage, Profit & Loss	9.8	12.9	13.0
4.	Simple & Compound Interest	26.0	21.3	26.4
5.	Ratio & Proportion	19.5	22.7	16.1
6.	Speed, Time & Distance	7.0	5.5	8.3
7.	Area and Volume	14.4	22.7	24.5
8.	Graphs of Statistics	19.8	20.3	21.5
9.	Symbolic Representation	14.6	12.5	28.5
10.	Four Fundamental Operations	16.9	14.4	37.1
11.	Laws and Assumptions	9.4	7.8	13.5
12.	Simple Equations and Problems	12.2	14.8	23.4
13.	Simultaneous Equations & Problems	1.1	9.4	16.6
14.	Formulae	15.6	7.8	20.8
15.	Graphs	3.7	16.7	20.8
16.	Solids	23.4	17.5	25.0
17.	Lines	27.6	21.9	33.3
18.	Angles	18.0	18.8	25.0
19.	Plane Figures	15.0	9.2	22.3
20.	Integrated	10.8	9.7	23.9

TABLE 9.11

Average Difficulty Values of the Objectives of the Middle Level Tests for IX, X & XI Grades

S. No.	*Objective*	*GRADE*		
		IX	X	*XI*
1.	Knowledge	21.7	19.4	27.7
2.	Skill	9.6	17.2	28.6
3.	Application	13.8	14.8	28.2
4.	Logical Reasoning	13.2	12.5	22.1

Even though it was expected that the topics would become easier when administered to higher grade students, there were few topics which were found to be difficult even at the higher grades. Samples being small we may not be able to generalise these trends. Still the fact remains that even higher grade students failed to respond to items on topics introduced in the earlier grades—at least in this Delhi school. It may be of interest to note that the general observation seems to be supported by the findings of this study that in Indian schools usually different topics are introduced discretely in different grades with little emphasis on higher objectives e.g. Application or Logical Reasoning.

The tests however had a significant proportion of items on these higher objectives. This might be one of the major reasons for the poor performance of our students on these tests. Tables of average difficulty values, especially Tables 9.8 and 9.11 support the contention. Results of this study as well as those in the survey reveal the lack of an integrated approach in introducing various topics in different grades and indicate the existing watertight compartments in various branches of mathematics in the present-day teaching of mathematics.

9.2 Regions—Mathematics Achievement

9.21 *Regions as a Variable.* In 1957 most of the States in India were reorganised on linguistic basis. Even though at the time of the survey the schools followed a uniform curriculum, textbooks and evaluation methods, observers had noticed differences as regards the educational standards—between different regions within a State. There are two main factors responsible for these regional imbalances. One is the past educational history of the region and the other the general socio-economic conditions of the people in the region. Hence, wherever information collected from the States indicated the possibility of regional imbalances those States were subdivided into regions reflecting those diversities.

It is hypothesised that the regions with good educational history and better socio-economic conditions will get higher mean achievement in mathematics than those regions which lack these. In the subsequent sections specific hypotheses within a State regarding these regional means and the interpretation of evidence supplied by the survey data in this direction are presented.

In most of the States this hypothesis holds good at all the three levels but in few states the trend in the results is opposite to the expected direction. However, in many cases regional differences could not be prominant possibly because of difficulty of the tests and the consequent low mean scores obtained by all the different groups in the State. Sections 9.22 to 9.210 deals with the States which were stratified into regions based on geographical contiguity, past educational histories, socio-economic background etc. These States are Andhra Pradesh, Gujarat, Kerala, Madhya Pradesh, Maharashtra, Mysore, Orissa, Rajasthan, Uttar Pradesh, while sections 9.211 and 9.212 deal with Central Schools and the State Jammu and Kashmir, wherein stratification was done on the basis of medium of instruction.

9.22 *Andhra Pradesh*. Andhra Pradesh was stratified into three regions viz., Telangana, Rayalaseema and Circars. The two regions Rayalaseema and Circars popularly known as Andhra area comprise of districts formerly belonging to Madras State. Telangana region comprise of districts which belong to former Hyderabad State. Andhra area had a longer history of educational progress, while in the Telangana region the story is different. Only Hyderabad city in this region has got relatively good educational facilities. As such it was expected that the mean score in Telangana region would be lower than that of the two regions Circars and Rayalaseema.

Findings of the survey as shown in the Table 9.12 are as expected at the primary and middle levels while at the high school level there is no definite trend. This can be explained by the inclusion of Hyderabad city in the high school level testing. Hyderabad city which belongs to Telangana region is the only part of the former Hyderabad State where full attention was paid for education while the remaining parts of the State were neglected by former rulers of Hyderabad State. At the time of survey, in Hyderabad city tests at primary and middle levels could not be administered and only high school tests could be administered. As the mean obtained by Hyderabad city is comparatively higher, the mean for the Telangana region including Hyderabad City is boosted up to make it comparable with the other regions.

9.23 *Gujarat*. Gujarat State was stratified into five regions viz., Kutch, Saurashtra, Sabarkantha, Ahmedabad and Baroda. Saurashtra region comprise of districts which belonged to former princely states, while Baroda comprise of districts belonging to former Baroda State. They have got good educational history and it was expected that these two regions will get higher means than those obtained by other regions. However these differences were not expected to be prominent as the general facilities for

TABLE 9.12

Regional Differences in Mathematics Achievement—Andhra Pradesh

Level & Form	Total Group n	m	s.d.	Region I n	m	s.d.	Region II n	m	s.d.	Region III n	m	s.d.
	Andhra Pradesh			Telangana			Rayalaseema			Circars		
P1	2135	13.6	7.0	707	9.8	4.1	834	15.8	7.2	594	14.9	7.5
P2	2136	13.1	6.2	707	9.8	3.7	842	15.0	6.5	594	14.2	6.6
M1	513	12.6	5.0	141	11.0	4.1	223	13.0	5.1	149	13.4	5.5
M2	516	12.6	4.6	140	11.2	4.4	225	13.0	4.3	151	13.2	4.8
H1	696	18.1	7.3	199	17.7	9.2	371	18.1	6.4	126	18.6	6.5
H2	723	19.3	7.7	236	20.0	9.7	360	18.9	6.2	127	19.3	6.8

TABLE 9.13

Regional Differences in Mathematics Achievement—Gujarat State

Level & Form	Total Group n	m	s.d.	Region I n	m	s.d.	Region II n	m	s.d.	Region III n	m	s.d.	Region IV n	m	s.d.	Region V n	m	s.d.
	Gujarat			Kutch			Saurashtra			Sabarkantha			Ahmedabad			Bardoda		
P1	1912	21.5	8.5	79	21.7	6.1	358	21.8	8.9	444	20.4	8.5	621	19.9	7.0	410	23.0	9.5
P2	1893	20.0	7.8	79	21.1	6.0	361	20.9	8.2	447	20.2	8.2	625	18.8	6.3	381	20.7	8.9
M1	482	17.2	7.3	20	17.6	6.7	100	16.5	6.7	107	18.7	9.0	154	17.6	7.2	101	16.7	8.1
M2	471	17.0	5.8	20	17.6	6.7	97	16.4	5.7	100	18.2	6.6	155	16.5	6.7	99	16.5	5.2
H1	338	24.8	10.4	15	30.6	10.1	70	20.3	9.4	77	28.3	11.4	98	24.6	8.9	78	24.3	10.1
H2	330	23.7	9.4	15	25.3	6.4	68	23.0	10.4	68	25.4	7.8	99	24.4	9.4	80	24.3	9.0

education are quite uniform throughout the State mostly due to the initiative taken by private organisations as well as government agencies.

The results do not show any clear cut trend. Kutch region got higher means at the three levels. However the sample consists of students from only 4 schools and as such we have to be cautious about interpreting these means. Of the other four regions, at the primary level the Saurashtra and Baroda have got higher means as expected even though the differences in means for the four regions are not appreciable. However at middle and high school levels Sabarkantha region scored higher mean than the other three regions contrary to the expectations. This inconsistency in the trends at the different levels is all the more striking because most of the schools selected for the survey were the same for all the three levels.

9.24 *Kerala*. The Kerala State was divided into three regions viz. Southern, Central and Northern. Southern and Central regions comprise of districts belonging to former princely states of Travancore and Cochin, while Northern region comprise of districts belonging to former Madras State. Central and Southern regions are considered to be educationally forward and as such it was expected that these regions would score higher than the Northern region.

Contrary to the expectations it is the Southern region which has got the lowest mean and this trend is consistent at all the three levels. Northern region, which was expected to score lower, got means close to Central region at all the three levels. The reasons for Southern region getting lower mean at all the three levels will be worth further exploration.

9.25 *Madhya Pradesh*. The State of Madhya Pradesh was stratified into six regions viz. Gwalior, Indore, Bhopal, Mahakoshal, Chattisgarh and Rewa. These regions were formed more or less on the basis of geographical contiguity and linguistic differences. Because of longer educational history of Mahakoshal region as compared to the other regions, it was expected that this region would score higher.

The results indicate that Mahakoshal region got higher mean than the other regions at primary level. However, there is no consistent trend among these results for the middle and high school levels. Possibly the low achievement in all these regions at these levels might have submerged any possible trends in the results.

9.26 *Maharashtra*. Maharashtra State was stratified into five regions viz. Marathwada, Western Maharashtra, Konkan, Vidarbha and Greater Bombay. Marathwada region was part of former Hyderabad State. The western Maharashtra and Konkan regions belonged to the old Bombay State. Vidarbha region belonged to former Madhya Pradesh State, Greater Bombay, being one of biggest cities in India, was considered as a separate region. All those regions have got different educational histories, socio-economic backgrounds and different language dialects.

Western Maharashtra and Bombay with good past educational history and relatively good socio-economic backgrounds were expected to perform

TABLE 9.14

Regional Differences in Mathematics Achievement—Kerala State

Level &	Total Group			Region I			Region II			Region III		
Form	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.
	Kerala			Southern			Central			Northern		
P1	1531	21.4	6.7	674	19.8	6.5	595	22.7	6.6	262	22.4	6.0
P2	1530	20.7	6.0	672	19.3	5.9	594	21.1	6.0	620	21.4	5.7
M1	306	16.5	6.2	131	14.8	6.1	114	17.7	5.8	61	17.9	6.4
M2	314	17.0	6.1	129	15.9	6.3	125	17.4	5.9	60	18.5	5.4
H1	711	29.5	9.5	290	28.2	9.0	225	30.6	9.9	196	30.1	9.3
H2	684	29.2	8.8	285	27.1	7.9	204	29.1	8.6	195	32.4	9.5

TABLE 9.15

Regional Differences in Mathematics Achievement—Madhya Pradesh

Level &	Total Group			Region I			Region II			Region III			Region IV			Region V			Region VI		
Form	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.
	Madhya Pradesh			Gwalior			Indore			Bhopal			Mahakoshal			Chattisgarh			Rewa		
P1	915	17.3	8.3	231	14.3	8.5	170	16.7	6.6	58	17.0	5.3	217	20.4	9.5	109	18.8	7.1	130	16.9	7.9
P2	911	15.7	7.4	232	11.7	6.5	170	14.8	5.8	62	13.9	6.2	214	19.7	7.9	107	17.4	6.5	126	17.0	7.1
M1	656	15.1	7.4	79	13.4	5.7	130	14.6	7.9	50	15.0	7.9	175	16.3	7.9	85	17.2	8.6	137	13.6	7.0
M2	637	14.6	6.3	81	14.9	6.3	130	14.0	5.1	50	14.4	5.6	165	15.1	6.8	85	15.6	8.6	128	13.9	5.0
H1	1497	18.2	7.0	241	18.8	7.2	321	16.9	6.2	81	17.9	5.5	312	18.0	7.8	240	18.9	6.8	302	18.8	7.3
H2	1399	19.8	8.5	238	20.3	7.4	313	18.5	7.2	84	20.5	6.4	271	19.4	8.2	211	20.1	7.1	292	21.0	11.6

better than the othere regions. Of the remaining regions Marathwada was expected to score lowest as this region being part of the former Hyderabad State was neglected by the then rulers during the pre-independence era.

As expected Western Maharashtra and Bombay regions scored appreciably higher than the other regions while Marathwada region scored low. The results revealed this trend consistently at all the three levels. As expected Bombay got slightly better score than the Western Maharashtra region.

9.27 *Mysore*. The Mysore State was stratified into five regions viz. Mangalore, Hasan, Dharwar, Gulbarga and Mangalore. Bangalore region (including Bangalore city which is one of the 12 big cities in India) and Hasan regions belonged to old Mysore state. Major portions of Dharwar and Gulbarga regions belonged to former Bombay and Hyderabad states respectively. Manglore region comprises of parts of old Bombay and Madras state. These five regions differs considerably in the cultural heritage and their past educational histories. Of these five regions Dharwar and Mangalore regions are advanced in many respects and had a longer history fo educational growth, while Gulbarga region is comparatively backard. As such it was expected that Dharwar and Mangalore regions would score higher means and Gulbarga region would be at the lowest end.

As expected the Mangalore region followed by Dharwar region scored appreciably higher than the other regions. The trend is consistent at all the three levels. At the Primary Level the means obtained by Mangalore region could favourably be compared with the highest mean achieved in the Nation. Contrary to the expectations it is the Bangalore region which got the lowest means among the regions consistently at all the three levels. Scrutiny of the results of the Bangalore region shows that the means obtained by Bangalore city are quite low as compared to the other urban or rural parts of the region. The reasons for Bangalore city getting lower means consistently at all the levels deserve further exploration.

9.20 *Orissa*. Orissa State was stratified into four regions viz., Cuttack, Balasore, Koraput and Sambalpur. Most of the parts of this state belong to erstwhile princely states. The growth of education in Orissa had been slow in the pre-independence era. However, efforts by the State Government after the independance has considerably improved the situation. Considering the past educational history of the regions and educational facilities available, it was expected that Cuttack region would score higher means and the Koraput region would stand at the lower end.

The results confirm the expectations by and large and the trend in the results is consistent at all the levels.

9.29 *Rajasthan*. The present Rajasthan State was formed by merging many princely states of various sizes and of different topographical features and geographical conditions. The state was stratified into five regions viz. Ajmer, Jodhpur, Bikaner, Udaipur and Kota—more or less on geographical contiguity. Of all the regions, Ajmer has a longer educational history As

TABLE 9.16

Regional Differences in Mathematics Achievement—Maharashtra State

Level &	*Total Group*			*Region I*			*Region II*			*Region III*			*Region IV*			*Region V*		
Form	*n.*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*
	Maharashtra			Marathwada			West Maharashtra			Konkan			Vidarbha			Bombay		
P1	1233	20.0	8.0	226	16.7	7.8	381	22.5	7.6	119	20.0	7.3	304	16.6	6.4	203	23.9	8.2
P2	1234	20.3	7.9	223	17.6	8.4	380	22.1	7.8	119	20.1	6.8	306	17.6	6.3	206	24.0	7.7
M1	3086	17.4	8.2	489	13.3	5.6	745	19.3	7.8	287	16.4	6.3	781	17.3	8.0	784	18.3	8.2
M2	3064	16.5	7.8	462	12.7	5.2	733	17.8	8.7	295	15.2	6.0	770	16.9	8.0	804	18.4	13.1
H1	1037	25.3	12.3	68	17.0	8.3	214	27.21	14.1	75	23.9	7.5	177	19.6	9.5	500	28.0	12.4
H2	994	24.8	11.0	66	19.2	8.7	182	27.5	12.1	78	24.2	8.1	173	20.2	8.9	490	26.4	11.4

TABLE 9.17

Regional Differences in Mathematics Achievement—Mysore

Level &	*Total Group*			*Region I*			*Region II*			*Region III*			*Region IV*			*Region V*		
Form	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*
	Mysore			Bangalore			Hasan			Dharwar			Gulbarga			Mangalore		
P1	2186	19.0	9.3	919	17.2	7.9	334	17.8	6.9	357	24.3	11.1	399	17.0	8.6	177	24.6	10.8
P2	2185	18.6	9.0	917	16.5	7.9	331	18.4	7.3	352	23.4	10.5	413	16.7	7.8	172	24.7	10.3
M1	682	16.7	8.2	321	15.5	7.3	85	14.6	7.7	111	18.5	8.3	120	18.8	10.3	45	22.2	8.8
M2	657	15.9	8.5	319	14.5	6.7	85	14.2	7.8	89	18.0	9.6	119	19.3	9.6	45	21.0	9.6
H1	1208	16.2	6.2	633	14.6	4.8	110	16.1	5.2	220	18.1	6.3	89	16.5	7.2	156	20.5	8.1
H2	1200	18.8	7.2	615	16.7	5.1	110	18.0	5.4	225	20.6	7.5	92	17.9	6.7	158	25.4	10.2

TABLE 9.18

Regional Differences in Mathematics Achievement—Orissa State

Level &	*Total Group*			*Region I*			*Region II*			*Region III*			*Region IV*		
From	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*
	Orissa			Cuttak			Baosore			Koraput			Sambalpur		
P1	455	22.1	7.9	170	23.0	8.5	120	22.6	7.3	80	19.4	6.9	65	22.2	7.2
P2	438	21.2	7.7	169	22.8	8.8	115	21.2	6.8	80	18.2	6.1	74	20.7	7.0
M1	1421	19.9	9.0	514	21.1	9.7	453	20.5	8.1	196	17.4	8.5	258	18.4	2.6
M2	1394	18.8	8.8	198	19.9	9.9	448	19.8	8.4	191	16.3	7.9	257	17.6	7.9
H1	957	26.7	11.0	379	27.7	11.3	273	25.2	9.8	146	26.1	11.3	159	27.6	11.3
H2	953	26.9	10.7	368	28.1	10.5	271	26.9	10.7	148	23.6	9.8	166	26.9	11.0

TABLE 9.19

Regional Differences in Mathematics Achievement — Rajasthan State

Level &	*Total Group*			*Region I*			*Region II*			*Regton III*			*Region IV*			*Region V*		
Form	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s.d.*	*n*	*m*	*s,d.*
	Rajasthan			Ajmer			Jodhpur			Bikaner			Udaipur			Kotah		
P1	388	18.8	16.9	6.1	119	4.2	145	19.9	7.6	40	14.9	5.5	105	16'5	6.5	79	13.9	5.6
P2	393	16.4	7.6	120	18.4	8.1	49	17.9	10.7	40	14.0	4.1	105	15.8	16.7	79	14.3	5.5
M1	1658	17.2	8.7	454	17.4	9.8	214	18.1	7.0	184	15.9	5.9	390	26.0	5.8	416	18.4	11.1
M2	1652	16.1	6.7	448	16.4	7.0	259	16.6	7.2	183	14.4	5.9	392	16.1	5.8	370	16.6	7.5
H1	353	19.9	7.6	100	18.4	6.4	55	19.9	7.0	35	20.1	10.8	84	19.0	7.6	79	22.7	8.2
H2	347	20.5	6.8	100	19.5	6.4	56	24.2	8.4	34	19.4	6.2	83	20.8	6.4	74	19.4	5.5

TABLE 9.20

Regional Differences in Mathematics Achievement—Uttar Pradesh

Level & Form	*Total Group*			*Region I*			*Region II*			*Region III*			*Region IV*		
	n	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d*
	Uttar Pradesh			Northern			Western			Eastern			Central		
P1	1483	18.0	8.3	211	17.9	6.2	476	18.8	9.1	236	17.6	8.4	560	17.5	8.3
P2	1483	17.5	8.0	211	18.6	6.9	479	18.2	8.7	236	17.9	8.4	557	17.0	7.4
M1	619	16.4	7.8	70	13.8	8.7	225	16.5	7.0	109	17.3	7.1	215	16.7	8.4
M2	621	17.0	7.9	70	14.5	5.2	225	16.5	6.9	110	18.6	6.9	216	18.2	10.2
H1	444	17.6	8.6	50	15.7	4.9	143	18.6	8.9	69	18.6	7.8	182	17.0	9.3
H2	429	19.4	8.6	49	16.7	4’9	137	20.5	9.4	70	18.6	7.9	175	19.5	8.9

such it was expected that this region would score higher than any other region.

At the primary level Jodhpur and Ajmer regions got higher means than the other regions. However, no consistent trend could be observed at middle and high school levels possibly because of the low scores obtained in all these regions submerging any trend.

9.210 *Uttar Pradesh.* The State of Uttar Pradesh was stratified into four regions viz. Northern, Western, Eastern and Central—more or less on the basis of geographical contiguity and administrative set-up. Considering the four regions Western and Central regions—as distinguished from the other two regions—had a longer history of educational growth. Many private agencies had taken an initiative in their educational growth even in the pre-independence era. As such it was expected that Western and Central regions would score higher than the other regions.

The results do not show any clear cut trend in the means obtained by the regions, at all the three levels, possibly because the low scores obtained at all the three levels by these regions might have submerged any possible trend.

9.211 *Jammu & Kashmir.* Considering the geographical contiguity Jammu & Kashmir state was stratified into two regions viz. Kashmir valley and Jammu. At the primary and middle levels urdu tests were administered in Kashmir valley while Hindi tests were administered in Jammu. However Hindi tests were administered in three schools at Srinagar. At the high school level English tests were administered in both these regions as mathematics is taught in English. A uniform syllabus is followed throughout the State. Considering the educational histories of these two regions, it was expected that the Jammu region would perform better than Kashmir valley on mathematics achievement tests. Table 9.21 present the results for the two regions as well as for the total state.

TABLE 9.21

Regional Language Differences in Mathematics Achievement—Jammu & Kashmir

Test	*Total Group*			*Region I Kashmir Valley (Urdu)*			*Region II Jammu (Hindi)*		
	n	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d*
P1	156	14.7	6.0	111	14.0	5.4	45	16.4	7.2
P2	154	15.2	6.6	109	14.7	6.2	45	16.3	6.2
M1	136	13.1	6.8	91	12.5	7.5	45	14.2	5.1
M2	134	12.9	6.6	89	12.2	7.2	45	14.1	5.3
H1*	217	18.1	5.7						
H2	218	18.5	5.1						

* Tests in English were administered at the High School stage in Jammu & Kashmir

Even though these results reveal the trend in the expected direction the differences in the performance cannot be solely attributed to either regional differences or language diversity—because of certain biases in the sample. Firstly in the Kashmir valley more schools from rural areas participated in the survey, while in Jammu region schools participating from rural and urban areas were equal in number. Secondly schools selected for the survey were spread over in one district in Jammu region while they were spread over three districts in the Kashmir valley region.

Thus it is clear that no definite statement can be made on either regional or language differences. It needs further probing to study these differences.

9.212 *Central Schools.* The Central Schools have English and/or Hindi as media of instruction—and they follow a uniform syllabus. It is known that the students who opt for English and Hindi are differ on some characteristics, as such it was decided to subdivide students from the Central Schools into the English group and the Hindi group.

In most of the cases the parents of students who opt for English medium belong to higher strata of Government service with sound socio-economic background. Further majority of these students had the nursery school background before their regular schooling started. Considering these factors in favour of English group it was expected that the English group would show better performance than the Hindi group. Table 9.22 presents the results in Central Schools.

TABLE 9.22

Language Group Differences in Mathematics Achievement—Central Schools

Test	*Total Group*			*Hindi Medium*			*English Medium*		
	n	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d.*
P1	310	20.5	8.2	137	17.4	7.2	173	22.9	8.4
P2	296	19.9	7.1	135	17.3	6.7	159	22.2	7.3
M1	284	17.9	8.7	79	14.6	6.2	205	19.7	9.3
M2	236	17.9	7.7	68	15.8	7.1	168	18.8	8.0
H1	412	19.1	8.3	111	17.0	5.9	301	20.0	9.1
H2	462	20.4	7.7	115	18.1	6.3	347	21.9	9.5

As can be seen from Table 9.22 the English group definitely performed better than the Hindi group at all the three levels. The differences in the achievement between these two groups are appreciable at the primary and middle levels and not so much at the high school level—possibly because the tests seem to be difficult at high school stage as compared to the other two levels. It may also be pointed out here that even though the performance of the Central Schools is comparable to the better performances of the other States at the primary and middle levels, the same thing cannot be said at the high school level. The reasons for such performance at the high school may be worth probing.

9.3 Sector Variable—Mathematics Achievement

9.31 *Urban/Rural Differences.* India is predominantly an agricultural nation with majority of the population living in rural areas. On the whole people in urban areas enjoy more educational facilities than those in the rural areas. Apart from this it is generally felt that the parents in the urban areas because of their occupational status and education are likely to take more interest in the education of their children than their counterparts in the rural areas. As such it was hypothesised that the urban school children will be superior to rural children in mathematics achievement. As explained earlier in the sampling chapter the urban areas were further subdivided into big cities and towns. Usually the educational facilities available in a big city are better than the remaining urban areas of that State. As such it was hypothesised that the achievement in mathematics in such big cities would be better than the remaining urban areas as well as the rural areas in the respective States. Table 9.23 present the means for total State, rural, urban sectors and for a big city if one is selected from the given state alon gwith sample sizes and standard deviations for these categories.

TABLE 9.23

Mathematics Achievement—Urban/Rural Differences

State	*Test*	*Rural*			*Urban*			*City*		
		n	*m*	*s.d*	*n*	*m*	*s.d*	*n*	*m*	*s.d*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
1. Andhra Pradesh	P1	1407	13.6	7.1	727	14.2	6.8		*Hyderabad*	
	P2	1403	12.7	6.1	733	13.7	6.1			
	M1	231	12.5	5.3	234	12.9	4.6			
	M2	281	12.5	5.4	235	12.9	4.6			
	H1	396	17.5	6.4	206	17.5	6.8	95	21.4	10.1
	H2	392	18.8	6.8	201	18.5	6.5	130	22.2	10.6
2. Assam	P1	100	24.0	8.3	100	22.7	8.8			
	P2	106	22.3	7.0	101	22.5	8.6			
	M1	96	14.6	6.9	80	16.2	8.9			
	M2	96	16.2	7.3	80	17.2	9.5			
	H1	129	18.7	10.6	274	17.6	7.8			
	H2	121	19.4	8.4	265	18.7	8.5			

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									Delhi	
	P1	99	28.7	12.5				451	23.0	8.6
	P2	102	27.0	8.7				487	23.5	8.7
3. Delhi	M1	134	16.0	5.7				430	17.7	9.3
	M2	130	16.4	5.2				427	18.5	9.9
	H1	53	19.7	6.3				369	24.7	10.2
	H2	53	20.8	7.2				383	24.2	9.6
									Ahmedabad	
	P1	852	20.9	8.7	640	21.6	8.4	420	21.0	7.3
	P2	876	20.2	8.1	613	20.2	8.2	404	19.1	6.3
4. Gujarat	M1	238	17.4	6.9	144	17.0	8.0	100	17.6	7.2
	M2	227	17.3	6.0	144	16.3	5.6	100	16.0	5.4
	H1	182	24.2	10.4	103	24.8	9.9	53	27.2	7.8
	H2	174	22.2	4.7	102	26.3	9.7	53	23.4	11.6
	P1	80	14.0	4.6	77	15.5	7.0			
	P2	70	14.1	6.3	85	15.4	6.9			
5 Jammu and Kashmir	M1	80	12.2	7.3	56	14.3	5.9			
	M2	80	12.9	7.5	54	12.6	5.2			
	H1	159	18.4	5.5	58	17.4	6.2			
	H2	162	18.7	5.0	56	18.1	5.7			
	P1	835	21.2	6.6	696	21.5	6.6			
	P2	835	20.6	6.1	695	20.9	5.9			
6. Kerala	M1	156	16.3	6.6	150	16.7	5.7			
	M2	150	16.8	6.5	159	17.1	5.6			
	H1				711	29.5	9.5			
	H2				684	29.2	8.8			
	P1	486	17.1	8.3	424	17.5	8.4			
	P2	487	14.9	7.3	423	16.7	7.3			
7. Madhya Pradesh	M1	347	13.6	5.9	309	16.7	7.9			
	M2	333	13.4	5.0	304	15.7	6.7			
	H1	789	17.8	6.7	708	19.3	7.8			
	H2	755	18.7	6.5	644	21.2	10.3			
									Bombay	
	P1	638	20.0	7.7	382	19.5	8.0	203	23.9	8.2
	P2	637	19.2	7.7	381	20.0	7.8	206	24.0	7.6
8. Maharashtra	M1	1224	16.1	7.8	1078	18.1	9.0	784	18.3	8.2

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
8. Maharashtra (*Continued*)										
	M2	1191	15.3	7.1	1068	16.9	7.0	803	17.7	9.4
	H1	249	23.9	10.3	285	22.1	10.0	500	28.0	12.4
	H2	211	22.3	9.7	288	24.1	12.3	490	26.4	11.4
									Bangalore	
	P1	1000	20.5	9.6	749	18.9	9.3	337	14.8	6.5
	P2	1111	19.6	9.1	744	19.2	9.2	330	18.9	6.3
9. Mysore	M1	330	17.6	9.2	257	16.4	7.6	95	13.8	4.3
	M2	340	17.3	9.2	222	15.7	8.0	95	11.9	4.2
	H1	560	16.3	6.5	548	16.9	5.7	100	12.6	4.5
	H2	574	19.0	7.1	528	19.2	7.9	98	15.1	5.7
	P1	241	21.6	7.8	194	22.7	8.1			
	P2	235	21.1	8.2	202	21.3	7.2			
10. Orissa	M1	741	19.5	9.3	680	20.3	8.6			
	M2	710	18.2	9.0	684	19.4	8.5			
	H1	465	24.7	10.2	492	28.7	11.4			
	H2	473	26.4	10.1	480	27.4	9.8			
	P1	179	17.0	6.4	135	17.4	7.2			
	P2	181	17.2	6.2	135	17.2	6.7			
11. Punjab	M1	155	16.4	6.9	160	18.3	8.7			
	M2	154	14.7	7.1	160	17.4	7.6			
	H1	452	18.7	7.1	165	20.9	8.8			
	H2	434	21.1	6.6	185	22.0	8.4			
	P1	35	21.8	7.7	100	17.3	8.6			
	P2	35	18.6	6.7	100	16.7	7.8			
12. Haryana	M1	45	17.7	7.3	95	16.0	7.5			
	M2	45	18.6	9.9	95	14.5	7.0			
	H1	84	19.9	7.0	116	21.1	7.7			
	H2	82	22.4	7.2	113	23.3	8.0			
	P1	234	16.6	6.0	154	17.3	6.2			
	P2	238	16.0	7.8	155	17.0	7.3			
13. Rajasthan	M1	777	16.0	7.6	881	17.1	7.0			
	M2	782	16.1	7.0	870	16.2	6.5			
	H1	178	18.9	7.0	175	21.0	8.3			
	H2	176	18.7	6.2	171	22.4	6.9			

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
									Kanpur	
14. Uttar Pradesh	P1	986	18.2	8.1	426	18.0	9.1	71	15.9	9.7
	P2	956	18.0	7.9	448	16.8	8.1	70	14.3	6.9
	M1	344	16.7	7.7	215	16.7	8.2	60	14.3	6.8
	M2	345	17.5	8.0	216	17.4	8.3	60	13.7	6.4
	H1	251	18.1	8.5	142	16.9	6.9	50	17.8	12.4
	H2	247	19.4	9.9	144	17.7	6.4	38	22.5	11.4
									Calcutta	
15. West Bengal	P1	84	20.0	6.7	70	26.0	8.6	65	24.0	8.8
	P2	91	18.9	6.2	65	23.0	6.9	65	22.8	7.2
	M1	125	15.9	9.8	95	24.7	13.4	90	23.9	10.9
	M2	95	15.1	7.2	95	23.1	13.0	80	22.7	11.0
	H1	289	21.8	10.0	159	33.8	13.1	60	31.3	11.3
	H2	269	20.6	10.3	161	33.8	12.7	54	30.9	11.6

(i) In Hyderabad (A.P.) tests could be administered at high school level only.

(ii) In Kerala high school tests in English were administered in the urban area only,

A look at this Table reveals that in five States viz., Kerala, Madhya Pradesh, Orissa, Rajasthan and West Bengal, the urban students got higher means than the rural students at all the three levels. In Punjab only at the primary level in P1 and at middle and high school levels the trend is in the expected direction. In form 2 at primary level the rural mean is slightly greater than the urban mean. It may be noted here that in Kerala at high school level, the sample consists of only urban students and as such no comparison between urban and rural students could be made at the high school level. Even in these five states although the results are in the expected direction the differences are not large. In other states as well the differences are not appreciable. This may be mainly because of the difficulty of the tests and consequent low scores which might have masked the differences within sectors.

In the previous chapter regional differences within a state were discussed. Therein it was mentioned that regional differences are there to some extent because of differences in urbanization. As such it was not expected that the trend in the urban/rural means in the regions will be necessarily the same as those at the State level. Table 9.24 shows the direction of differences in the urban-rural means in the regions within States. (At the middle level these figures at the regional level were not computed and as such those could not be given in the table).

Though the results at the regional level are not always consistent with the results at the State level, a majority of the regions taken over all the

TABLE 9.24

Mathematics Achievement of Urban Students vs. Rural Students within Regions

State/Group	*Total Group*			Region I				Region II				Region III				Region IV				Region V				Region VI			
	P	M	H		P	M	H		P	M	H		P	M	H		P	M	H		P	M	H		P	M	H
Andhra Pradesh	+	+	—	Telangana	—		—	Rayal seema	—		+	Circars	+		—												
Assam	?	—	—																								
Delhi	—	+	+																								
Gujarat	+	—	+	Kutch	*		*	Saurashtra	—		+	Sabarkanta	—		?	Ahmedabad	+		+	Baroda	+		+				
Jammu & Kashmir	+	?	—																								
Kerala	+	+		Southern	—	*	*	Central	+		*	Northern	—		*								*				
Madhya Pradesh	+	+	+	Gwalior	+		+	Indore	—		?	Bhopal	+		+	Mahakoshal	+		—	Chattisgarh	+		+	Rewa	+		+

Maharashtra	? + +	? Marathwada ?	+ West. Mhr. ?	? Konkan +	+ Vidarbha +	
Mysore	— — +	? Bangalore +	— Hasan +	— Dharwar +	+ Gulbarga ?	+ Mangalore ?
Orissa	+ + +	— Cuttack ?	+ Balasore +	+ Koraput +	? Sambalpur —	
Punjab	? + +					
Haryana	— — +					
Rajasthan	+ + +	? Ajmer +	+ Jodhpur +	— Bikaner +	? Udaipur +	+ Kota +
Uttar Pradesh	— — +	+ Northern —	— Western —	— Eastern ?	? Central —	
West Bengal	+ + +					

+ : Urban students achivement is greater than that of the rural students in both the forms
— : Rural students achievement is greater than that of the urban students in both the forms
? : Urban students achievement is greater than that of the rural students in one form and the other way in the second form.
+ : No students in the sample from *rural* area.

States, reveal trends in the expected direction. That is to say the variable of urbanisation and consequent increase in educational facilities produce better results.

9.32 *Performance of Big Cities in India.* As explained earlier for comparing the performance of students of big cities with that of the remaining State eight big cities were selected in the sample. Actually data could be collected from seven cities only. These are Hyderabad, Delhi, Calcutta, Bombay, Bangalore, Kanpur and Ahmedabad. Due to some administrative difficulties only the high school level tests could be administered in Hyderabad city.

In the case of Bombay, the city means are considerably better than means obtained by the remaining rural areas in that State at all the three levels.

In Hyderabad also, at high school level the city means are considerably greater than the mean obtained by the remaining urban and rural areas of the State. In Calcutta though the city means are considerably greater than rural means, they are slightly less than the means obtained by the remaining urban areas.

These results are consistent at all the levels. Thus the results definitely show the urban students' superiority over rural students in mathematics achievement in West Bengal. In the case of Delhi the results are quite interesting. At middle and high school levels the results definitely show the urban students' superior performance. However at the primary level the rural students got higher means than the urban students. The difference in the means are quite large. This is not only contrary to expectations but contradict the previous studies conducted in Delhi as regards urban/rural differences in achievement. A close look at the school means revealed that two out of the five schools which participated in the survey from the rural area got as high as 80% mean achievement which in turn increased the mean of the rural students considerably. Possibly the testing procedure in these two school might not have been strictly according to the procedures laid down by the project staff—leading to copying etc., on the part of the students.

In the case of Ahmedabad, Kanpur and Bangalore cities the results do not support the expectations. In Gujarat the means for the city of Ahmedabad, urban and rural sectors neither show any appreciable differences nor do they show any consistency in the trends. In Uttar Pradesh at the primary and middle levels the results are contrary to the expectations i.e., the rural mean is found to be greater than the urban mean which in town is greater than the Kanpur city mean. At both these levels the city mean is quite below the rural and urban means. At the high school level the urban means are lowest in both the test forms. Similar is the case of Bangalore getting considerably lower means at all the three levels.

9.33. *Concluding Remarks.* Thus the results show all possible combinations and hence one cannot make any categorical statement regarding the urban students superiority or otherwise vis-a-vis mathematics achievement for the country as a whole. Lack of clear cut trends or consistencies are not surprising though, if one considers the diversity of the factors which are likely to be influenced by urbanisation and which have got direct bearing on student achievement. For example parent's education, occupational status, physical environment, crowded schools and dwellings, efficiency of the Municipal Administration, all these and other factors, can influence the students' achievement to a considerable extent.

This partly explains lack of urban superiority in some states. Further explorations are necessary to study the factors which are responsible for the results to be in the expected direction in case of Bombay, Calcutta etc. but not in case of Kanpur, Bangalore etc.

The results are quite comparable to the I.E.A. study. In this study out of twelve countries which participated in the survey in case of only two countries the trend is in the expected direction viz., urban students superior to rural students.

The above reasoning indicates the need to control some variables relating to environmental conditions so as to make the efficiency of the educational system independent of place of residence of the students whether in the urban area or the rural area. It is not that rural students by definition are low achievers, much depends on the educational facilities provided to them.

CHAPTER X

MATHEMATICS ACHIEVEMENT—SCHOOL VARIABLES (MANAGEMENT, HIGHER MATHEMATICS AND STREAMS)

10.1 Management

One of the important school variables which may have some bearing on students achievement is the type of management which is running the school. In India types vary from state to state considerably. For the survey purpose however the schools were divided into two broad categories on the basis of management variable viz, government schools and non-government schools. Government schools include all the schools run by the State governments, local bodies like Corporation, Municipalities, Zilla Parishads, Panchayats etc., while non-government schools include private schools and government-aided but privately managed schools. In the pre-independence days the enthusiasm and initiative taken by religious and social organisations was responsible for spreading education to masses. These organisations played vital role in the general improvement in the education of the country and in some state they did pioneering efforts in this direction. Even after independence wherein more involvement on the part of government in the expansion of education took place, some of the schools run by these private organisations can be easily adjudged as best. However there is also now a large group of private schools run more or less on commercial lines with profit motive.

The rising number of private schools with high fees suggests that there is a feeling among parents that the educational facilities provided in the non-government schools are better than in the government schools. This may not be true in case of all the schools. Presently state governments are trying to increase the number of model schools with adequate facilities. It was hypothesised that the non-government schools would score better than the government schools in mathematics achievement. Table 10.1 presents the sample sizes, means and standards deviations obtained by these two categories of schools within each state.

Out of the fifteen states only in four states viz. Andhra Pradesh, Jammu & Kashmir, Punjab and Rajasthan the trend is in the expected direction—consistently at all the three levels. In the remaining states there is no clear-cut trend in the results in favour of or contrary to the hypothesis mentioned. The results are not surprising though. In some of the states like Gujarat, Maharashtra etc. the government schools especially at the high school level are in a minority and are run more as model schools.

TABLE 10.1

Mathematics Achievement of Students in Government and Non-Government Schools

State/Group	*Test*	*Government*			*Non-Government*		
		n	*m*	*s.d.*	*n*	*m*	*s.d.*
1	2	3	4	5	6	7	8
1. Andhra Pradesh	P1	1800	31.2	6.6	335	15.3	8.6
	P2	1797	12.7	5.6	339	15.0	8.5
	M1	463	12.6	5.1	50	13.6	4.3
	M2	465	12.7	5.5	51	13.1	4.1
	H1	489	17.6	7.2	205	18.9	7.8
	H2	505	19.3	9.5	218	19.5	8.0
2. Assam	P1	50	22.6	7.0	155	23.7	8.4
	P2	52	21.5	7.1	160	22.6	8.4
	M1	35	15.4	9.3	141	15.3	7.3
	M2	35	16.1	8.4	141	16.8	8.3
	H1	203	18.0	8.3	200	17.9	9.3
	H2	197	19.8	9.1	189	17.8	7.6
3. Delhi	P1	453	22.7	9.0	97	29.8	10.6
	P2	430	22.1	8.0	159	29.5	9.4
	M1	416	17.8	8.6	148	16.1	7.7
	M2	404	18.1	9.6	152	17.7	7.7
	H1	303	22.5	9.2	119	28.3	10.4
	H2	317	22.1	8.3	119	28.3	9.4
4. Gujarat	P1	329	23.5	10.7	1583	20.7	7.7
	P2	351	22.4	10.0	1542	19.4	7.1
	M1	81	17.2	6.7	401	17.5	7.8
	M2	61	16.3	6.7	410	16.9	5.7
	H1	51	21.5	6.6	287	25.8	10.8
	H2	48	23.2	9.1	282	23.8	9.2
5. Jammu & Kashmir	P1	121	14.2	4.7	36	16.5	8.7
	P2	120	14.5	5.6	35	17.5	8.9
	M1	105	12.0	7.0	31	16.6	4.2
	M2	105	12.5	6.9	29	14.3	5.8
	H1	197	17.7	6.0	20	22.3	7.0
	H2	198	18.5	5.5	20	19.1	6.1
6. Kerala	P1	659	21.0	6.6	872	21.7	6.7
	P2	657	20.8	6.1	873	20.7	6.0
	M1	136	16.2	6.4	170	16.7	5.6
	M2	139	17.1	5.6	170	16.8	6.3
	H1	67	29.3	8.6	644	29.5	10.0
	H2	67	31.2	9.1	617	29.0	8.8

1	2	3	4	5	6	7	8
7. Madhya Pradesh	P1	900	17.2	8.3	15	20.5	8.5
	P2	895	15.8	7.4	16	12.3	5.9
	M1	621	14.8	8.6	35	21.0	11.1
	M2	602	14.3	6.3	35	20.0	11.9
	H1	1199	17.7	6.7	300	20.2	7.8
	H2	1142	19.5	8.5	257	21.3	8.6
8. Maharashtra	P1	760	20.1	7.6	473	17.8	8.6
	P2	760	20.1	7.8	474	20.2	8.1
	M1	784	14.9	6.9	2300	18.2	8.5
	M2	748	14.3	6.1	2315	17.2	8.1
	H1	98	25.62	9.3	939	25.32	11.7
	H2	102	26.02	9.7	887	24.65	10.9
9. Mysore	P1	1746	19.1	9.5	440	18.8	8.4
	P2	1752	18.6	9.2	433	18.4	8.9
	M1	246	16.0	8.1	436	17.0	8.2
	M2	254	15.4	8.6	403	16.3	9.3
	H1	576	15.5	7.8	632	16.9	8.4
	H2	583	17.9	8.6	617	19.6	9.7
10. Orissa	P1	185	22.1	7.3	250	22.2	8.7
	P2	185	21.4	7.3	253	21.8	8.2
	M1	579	20.3	9.3	842	19.6	10.4
	M2	568	19.2	9.4	826	18.7	10.2
	H1	375	28.4	11.1	582	25.7	10.7
	H2	366	26.9	10.2	587	26.8	10.2
11. Punjab	P1	239	16.9	6.4	75	18.0	7.6
	P2	242	16.6	6.0	74	19.2	7.5
	M1	245	16.8	6.9	70	18.9	10.6
	M2	229	15.8	7.2	85	17.0	7.9
	H1	497	19.3	7.9	120	19.4	6.4
	H2	500	21.1	7.1	119	22.5	7.2
12. Haryana	P1	70	19.8	8.3	65	17.0	8.6
	P2	70	18.5	6.3	65	15.9	8.5
	M1	85	17.9	7.0	55	14.5	7.7
	M2	85	17.3	8.8	55	13.9	6.9
	H1	148	20.7	7.2	52	20.2	8.1
	H2	145	23.3	8.0	50	21.8	6.6
13. Rajasthan	P1	328	16.6	5.9	60	18.6	7.5
	P2	333	16.0	6.1	60	18.6	6.2
	M1	1346	17.1	9.0	312	17.9	7.2
	M2	1346	15.9	6.7	306	16.9	7.1
	H1	298	19.8	7.4	55	20.6	7.4
	H2	293	20.0	8.1	54	23.7	6.9

1	2	3	4	5	6	7	8
14. Uttar Pradesh	P1	613	18.2	8.5	870	17.9	8.2
	P2	607	17.2	7.9	876	17.7	8.0
	M1	75	15.2	7.7	544	16.6	9.0
	M2	75	16.1	8.1	546	17.2	8.2
	H1	86	18.1	8.1	358	17.5	8.8
	H2	75	19.7	5.1	354	19.5	8.8
15. West Bengal	P1	30	25.6	8.7	189	22.9	8.1
	P2	35	22.2	6.8	186	21.1	7.0
	M1	30	26.6	12.2	275	20.4	11.9
	M2	28	22.5	11.1	242	19.9	11.2
	H1	60	32.3	13.4	448	25.8	12.1
	H2	58	27.5	10.4	426	25.9	13.0

In the States of Haryana and West Bengal the results show the reverse trend—consistently at all the three levels. The differences between the government and non-government schools are quite large at all to three levels in favour of government schools. It may be noted that most of the schools in West Bengal fall under the category 'Non-Government' and the government schools which are few in number are run more or less on model basis and accordingly these differences were not surprising in the case of West Bengal. However the same thing cannot be said in the case of Haryana wherein the majority of the schools are run by the government. However the opposite results obtained by the neighbouring state Haryana and Punjab are quite interesting. Further, more controlled studies may throw light on these results.

As regards the other States there are some deviations possibly due to sampling fluctuations. In Delhi at the primary and high school levels the differences are quite large in favour of non-government schools, while at the middle level the difference is not much but it is in favour of government schools. The same is the case with Maharashtra.

The results clearly show that any attempt to relate management type and achievement in a cause and effect relationship will be misleading. Whether it is goverment or non-government what counts is the system followed i.e., the school and educational facilities provided rather than the management type *perse*. After seeing the trends in different states and management types prevalant in these states, one may infer although hesitatingly that in those states where the government schools are not in majority they are more likely to run on lines of model schools and hence are likey to score better than non-government schools while in the states where the government schools are in the majority they are not likely to score better than the non-government schools.

10.2 Higher/Lower Mathematics

In most States provision has now been made to opt for higher or lower mathematics after the middle level education is completed. Labels to describe these two stages used in the states are however not the same. In some states the higher mathematics is known as Advanced, Elective, Optional mathematics, while the lower mathematics is labelled as Elementary, General or Compulsory mathematics. Generally speaking Higher mathematics syllabus contains more of Algebra and geometry as compared to Lower mathematics which contains more of Arithmetic and Graphs. Further, the specific topics included in the curricula of these courses are also somewhat different from state to state. It was expected that the students pursuing Higher mathematics courses would score better than those pursuing Lower mathematics course. The results are presented in Table 10.2.

The results confirm the expectation in all the states except Jammu & Kashmir and Punjab. In Punjab the difference in the means of these groups is not much. In Jammu & Kashmir the students in the sample, opting for Higher mathematics group is quite small as compared to other group. The difference in the negative direction even though small may be due to sampling and fluctuations. In most of the states the differences in the means are quite large. Even though the students taking Higher mathematics have scored higher than those taking Lower mathematics, still they have not obtained desirable standard e.g. the highest performance of Higher mathematics group comes to only 46%.

10.3 Streams

In many states, the tests were given to XIth grade beginners. In most of the states the students by that time had opted for different streams. At the high school the sample in many states consisted mainly of students opting for Science and Humanities streams. A few students from other streams like Agriculture, Commerce and Technical were also there, but as the number of these other streams was very small, the comparisons of means could be restricted only to the Science and Humanities streams. It was expected that the students offering Science streams would score higher than those from Humanities group. The results are presented in Table 10.3.

The results in Table 10.3 support the expectations in all the states except in Maharashtra and Orissa States. In many states the difference between these two groups is quite large. In Orissa State there was a large number of students who did not indicate their stream, as such nothing can be said about the negative directions in the difference. In Maharashtra in all regions except Bombay, the Science group performed better than the Humanities group. However in the Bombay city the Humanities group scored much better than the Science group. This pulled down the mean for Science group for the total state. The possible reasons may be that most of the students opting for Humanities might have selected Advanced Arithmetic. Further probing in this regard is worth taking. In many States the Science group obtained more than the guess score, but still the performance was not upto the desirable standard—e.g. the highest mean for the Science group comes to be 41%.

TABLE 10.2

Mathematics Achievement of Students taking Higher Mathematics and Lower Mathematics

State Group	*Test Form*	*Higher Mathematics*			*Lower Mathematics*		
		n	*m*	*s.d.*	*n*	*m*	*s.d.*
1. Andhra	I	429	19.38	5.9	254	16.02	5.9
	II	454	20.51	7.1	259	17.52	6.0
2. Assam	I	164	21.33	9.0	227	15.80	8.0
	II	142	23.26	8.6	233	16.56	7.3
3. Delhi	I	292	26.72	9.6	100	19.93	6.8
	II	323	25.71	8.9	93	17.75	6.9
4. Gujarat	I	53	30.36	8.1	282	23.76	9.8
	II	54	30.42	10.8	266	22.55	7.8
5. Jammu & Kashmir	I	13	18.00	4.9	196	18.22	5.9
	II	8	17.37	3.2	202	18.69	5.2
6. Madhya Pradesh	I	707	19.60	8.2	765	16.96	5.7
	II	664	25.98	11.4	711	17.67	6.5
7. Maharashtra	I	476	28.48	11.1	531	23.33	10.7
	II	487	27.80	11.5	486	22.04	9.8
8. Mysore	I	790	17.29	6.7	412	15.86	6.5
	II	748	19.09	7.1	442	18.35	7.2
9. Orissa	I	572	29.31	11.8	358	22.21	9.5
	II	576	28.82	10.8	341	23.15	9.0
10. Punjab	I	172	19.26	8.0	404	19.30	7.5
	II	163	21.97	7.3	405	21.72	7.1
11. Haryana	I	71	23.08	7.9	125	19.41	6.6
	II	69	25.66	7.3	119	21.55	7.2
12. Rajasthan	I	181	22.00	8.2	144	17.16	6.2
	II	200	22.00	6.9	143	18.30	5.9
13. Uttar Pradesh	I	75	18.94	11.3	352	17.37	8.1
	II	66	15.63	6.2	335	19.26	7.7
14. West Bengal	I	373	29.06	12.8	123	19.74	7.7
	II	367	28.89	12.8	110	19.80	9.9
15. Central Schools (English)	I	199	21.95	9.5	77	16.46	7.2
	II	244	23.89	9.7	70	17.54	6.7
16. Central School (Hindi)	I	60	18.51	6.2	47	15.10	5.2
	II	71	19.64	6.7	43	15.55	4.7
17. Public Schools	I	46	36.73	14.9	33	23.96	7.2
	II	37	36.27	13.4	34	25.91	10.1

TABLE 10.3

Mathematics Achievement of Students Opting for Science and Humanities Streams

State/Group	*Test Form*	*Science*			*Humanities*		
		n	*m*	*s.d.*	*n*	*m*	*s.d.*
1. Andhra Pradesh	I	379	18.67	7.2	138	17.56	5.0
	II	383	19.75	7.5	144	18.88	6.9
2. Assam	I	235	20.99	8.5	105	14.34	7.8
	II	224	22.33	8.2	106	13.61	5.8
3. Delhi	I	276	26.64	9.6	90	19.83	10.3
	II	296	25.80	8.8	96	19.09	9.9
4. Gujarat	I	176	26.97	8.3	26	20.27	7.9
	II	175	25.30	9.3	19	22.74	10.5
5. Jammu & Kashmir	I	79	19.16	6.0	122	17.72	5.5
	II	67	18.82	4.6	137	18.52	5.2
6. Madhya Pradesh	I	1049	18.71	7.5	394	17.11	5.8
	II	1001	20.77	9.3	349	17.37	5.0
7. Maharashtra	I	590	24.54	10.5	170	25.76	8.3
	II	571	24.51	11.8	168	24.84	8.9
8. Mysore	I	871	16.29	5.6	311	16.03	5.8
	II	848	18.91	6.4	336	18.48	6.7
9. Orissa	I	175	24.58	10.1	133	27.51	11.0
	II	180	24.97	10.0	124	26.04	9.8
10. Punjab	I	428	19.05	7.1	88	16.43	7.5
	II	417	21.73	6.7	99	17.64	7.0
11. Haryana	I	179	20.76	7.6	18	18.11	4.2
	II	172	23.39	7.5	22	20.31	6.5
12. Rajasthan	I	224	21.31	7.8	95	19.55	5.1
	II	222	22.23	6.9	95	17.36	6.4
13. Uttar Pradesh	I	305	18.30	9.7	106	16.41	6.6
	II	299	20.32	9.5	99	16.37	4.8
14. West Bengal	I	371	28.96	12.6	97	18.59	7.2
	II	361	28.46	13.1	82	19.15	8.6
15. Central Schools (English)	I	256	20.94	9.3	34	14.38	5.2
	II	297	22.87	9.7	36	16.22	5.6
16. Central Schools (Hindi)	I	74	17.83	6.1	36	15.36	5.2
	II	78	19.12	6.7	37	16.05	4.8
17. Public Schools	I	69	33.55	13.3	13	19.84	10.9
	II	61	33.72	10.0	15	22.60	10.3

CHAPTER XI

MATHEMATICS ACHIEVEMENT--STUDENT VARIABLES (SEX AND AGE)

11.1 Mathematics Achievement—Sex Variable

Many research studies conducted in India and abroad suggest the boys' superiority over girls in educational achievement in general and numerical ability in particular. Some of these research studies have, however, pointed out that the differences cannot be solely attributed to the sex variable but rather to the different expectation of roles to be played in a given society and different educational facilities provided to girls. Accordingly, considering the Indian situation it was hypothesised that boys would score higher than girls on mathematics achievement tests at all the three levels in most of the regions of this country.

Table 11.1 presents sample sizes, means and standard deviations for boys and girls for all the states/groups of schools which participated in the survey. The results clearly show the boys' superiority over girls as per the expectations at all the three levels. Only in case of Delhi and Mysore the trends are in the opposite direction at one or two levels. In West Bengal only in one form at primary level the result is contrary to the expected direction. In most of the cases of these differences between the means obtained by boys and girls are quite large. It may be pointed out here that the socio-economic conditions and educational facilities provided to the girls such as seperate schools or different shifts for girls exclusively and providing lady teachers in the schools differ considerably from state to state. These factors contribute to intensity in differences of boys and girls means in the states.

In Delhi the reverse trend at primary level in both the forms and at middle level in one form may be due to the socio-economic composition of girls as against boys attending the common school system. In Delhi in most of the cases boys belonging to higher middle class group go to public schools or good private schools while their sisters go to the govt. schools and other less costly private schools in the neighbourhood. Thus in the municipal schools the proportion of boys from lower socio-economic group to those from higher socio-economic group was much more than the proportion of girls from these categories.

These results are consistent with the I.E.A. findings. There also the results support the conventional expectation of boys' superiority over girls in mathematics achievement. However between country analysis revealed

TABLE 11.1

Mathematics Achievement of Boys and Girls in States

State/Group	*Test*	*Boys*			*Girls*		
		n	*m*	*s.d.*	*n*	*m*	*s.d.*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1. Andhra Pradesh	P 1	1555	13.6	7.1	580	13.4	6.4
	P 2	1554	13.1	5.7	582	12.9	6.6
	M 1	408	12.9	5.1	105	11.5	4.7
	M 2	416	12.6	4.6	100	12.5	4.4
	H 1	537	18.6	7.7	158	16.3	5.7
	H 2	561	19.7	7.7	159	17.7	7.1
2. Assam	P 1	174	23.4	8.6	31	23.6	7.8
	P 2	184	22.6	8.1	28	20.8	4.6
	M 1	152	15.4	7.4	24	14.8	9.5
	M 2	156	16.9	7.8	20	15.3	11.5
	H 1	325	18.7	8.2	77	17.5	11.2
	H 2	315	18.9	8.2	71	18.9	9.4
3. Delhi	P 1	356	21.8	8.1	194	27.9	11.1
	P 2	374	22.4	8.1	215	27.0	9.4
	M 1	386	17.4	7.5	178	17.2	10.6
	M 2	383	17.6	7.2	174	18.8	12.2
	H 1	290	24.7	9.2	130	22.9	11.3
	H 2	304	24.6	8.6	128	21.5	10.8
4. Gujarat	P 1	1422	21.5	8.5	490	20.0	7.7
	P 2	1433	20.4	7.9	460	18.7	7.4
	M 1	383	17.6	7.5	99	16.6	8.1
	M 2	387	17.3	6.3	84	14.9	6.7
	H 1	277	25.9	10.5	61	19.7	9.8
	H 2	264	24.7	9.3	66	20.3	7.7
5. Jammu & Kashmir	P 1	118	15.1	6.3	39	13.2	5.2
	P 2	121	15.9	6.8	34	12.4	5.1
	M 1	103	13.8	7.1	33	10.8	5.5
	M 2	97	13.5	6.0	37	11.2	7.9
	H 1	203	18.4	5.6	6	10.8	6.1
	H 2	211	18.7	6.1	3	8.3	7.8
6. Kerala	P 1	1065	22.4	6.7	466	18.9	5.7
	P 2	1074	21.6	6.0	456	18.7	5.5
	M 1	226	17.6	6.5	80	13.3	5.3
	M 2	234	17.8	6.4	81	15.5	4.2
	H 1	532	30.9	9.9	177	25.3	7.4
	H 2	509	29.9	9.3	174	27.2	6.9

1	2	3	4	5	6	7	8
7. Madhya Pradesh	P 1	728	16.9	8.1	187	18.7	9.1
	P 2	721	15.4	5.2	190	16.9	8.1
	M 1	530	15.5	7.8	129	13.0	5.3
	M 2	506	14.7	6.5	130	14.3	8.1
	H 1	1241	18.7	6.4	252	16.0	8.1
	H 2	1177	20.4	8.9	219	16.9	5.6
8. Maharashtra	P 1	859	20.3	6.6	374	19.1	8.1
	P 2	823	21.0	8.0	411	18.9	7.5
	M 1	2331	17.4	8.4	755	16.1	7.1
	M 2	2214	17.2	8.9	810	16.1	9.0
	H 1	751	26.3	12.3	280	23.0	11.2
	H 2	725	25.5	10.7	261	23.1	10.8
9. Mysore	P 1	1650	18.8	9.4	536	19.5	9.0
	P 2	1631	18.4	9.1	554	19.2	8.6
	M 1	545	17.0	8.5	137	15.3	6.8
	M 2	515	16.2	8.6	142	15.2	7.6
	H 1	969	16.2	7.7	238	16.5	6.3
	H 2	943	18.7	8.4	257	19.3	7.8
10. Orissa	P 1	317	22.9	7.9	118	20.0	8.2
	P 2	315	22.0	7.6	123	19.1	7.4
	M 1	1123	20.6	9.4	298	17.3	6.7
	M 2	1091	19.4	9.0	303	17.2	8.3
	H 1	796	26.9	11.3	161	26.0	9.4
	H 2	792	27.0	10.3	159	26.5	9.3
11. Punjab	P 1	212	17.8	5.7	102	15.9	6.2
	P 2	209	17.7	6.7	107	16.3	5.4
	M 1	231	18.3	8.3	84	15.0	6.0
	M 2	216	16.5	7.7	98	15.3	6.5
	H 1	538	19.8	7.5	74	15.6	7.9
	H 2	518	22.3	6.8	95	16.4	7.1
12. Haryana	P 1	65	20.3	8.3	70	16.8	8.4
	P 2	65	18.5	7.9	70	16.0	7.1
	M 1	87	18.3	7.9	53	13.6	5.4
	M 2	90	17.9	8.3	50	12.4	6.9
	H 1	167	21.0	7.7	32	18.2	5.3
	H 2	164	23.1	7.6	30	22.9	7.1
13. Rajasthan	P 1	353	17.0	6.6	35	15.7	7.2
	P 2	348	16.5	6.2	45	15.8	7.9
	M 1	1523	17.9	7.2	135	17.4	8.9
	M 2	1530	16.2	6.9	122	15.1	5.6
	H 1	337	20.1	7.8	14	16.6	5.8
	H 2	329	20.7	6.9	17	18.1	5.3

1	2	3	4	5	6	7	8
14. Uttar Pradesh	P 1	1293	18.5	8.4	190	14.3	7.0
	P 2	1262	18.0	8.1	221	14.4	6.7
	M 1	544	17.0	7.9	65	13.5	5.6
	M 2	556	17.7	8.0	65	14.6	3.7
	H 1	406	17.7	8.4	36	17.0	10.5
	H 2	386	19.5	8.4	40	19.0	4.5
15. West Bengal	P 1	191	22.9	8.3	28	26.0	7.2
	P 2	191	21.3	7.2	30	20.6	6.0
	M 1	270	21.3	12.3	35	18.4	9.8
	M 2	238	20.6	11.5	32	17.3	8.9
	H 1	484	26.8	12.5	22	21.9	10.9
	H 2	463	26.3	12.7	21	22.6	13.4
16. Central Schools (English)	P 1	128	23.6	8.4	45	20.9	8.0
	P 2	120	22.7	7.3	39	20.6	6.8
	M 1	159	19.9	9.7	46	16.1	7.0
	M 2	115	19.8	8.4	53	16.5	7.1
	H 1	220	21.4	9.2	74	16.7	7.9
	H 2	270	23.1	9.6	69	18.2	7.8
17. Central Schools (Hindi)	P 1	104	17.8	7.1	33	16.2	7.2
	P 2	95	18.3	7.1	40	14.8	5.0
	M 1	54	15.0	6.6	25	13.6	5.3
	M 2	47	16.9	7.7	21	13.3	4.6
	H 1	82	17.6	5.9	28	15.3	5.6
	H 2	82	19.2	6.4	33	15.4	5.4
18. Public Schools	P 1	25	28.2	9.2	45	23.6	6.7
	P 2	30	27.0	9.2	45	24.0	7.5
	M 1	62	30.1	11.3	18	22.0	7.5
	M 2	62	26.9	10.0	18	23.8	7.9
	H 1	67	32.9	14.3	15	24.4	8.9
	H 2	61	33.3	10.0	16	25.5	12.6

that in these countries where the pattern is co-educational rather than single sex schools, the differences between boys and girls is less. The situation in India is quite similar, the evidence, however, is not sufficient and clear to interrelate the different school patterns followed in the states and mathematics achievement of boys and girls.

Table 11.2 presents the trend in the boys vs. girls comparisons in the regions within a state. In the states of Gujarat, M.P., Rajasthan, U.P. the number of girls from some of the regions in the sample is small i.e. around 10 and hence no interpretation could be made for these regions. For the remaining states in most cases the results for the regions within a state are in the expected direction.

TABLE 11.2

Mathematics Achievements of Boys and Girls in Regions within States

State/Group	Total Group			Region I			Region II			Region III			Region VI			Region V			Region VI		
	P	M	H	P	M	H	P	M	H	P	M	H	P	M	H	P	M	H	P	M	H
1		2			3			4			5			6			7			8	
A.P.	+	+	+	+	Telengana	+	+	Rayalseema	+	+	Circars										
Assam	?	+	+																		
Delhi	—	?	+																		
Gujarat	+	+	+	+	Kutch	+	+	Saurashtra	*	+	Sabarkantha	*	+	Ahmedabad	+	+	Baroda	+			
J & K	+	+	+																		
Kerala	+	+	+	+	Southern	+	+	Central	+	+	Northern	+									
M.P.	--	+	+	*	Gwalior	+	+	Indore	+	?	Bhopal	*	?	Mahakoshal	+	+	Chattisgarh	+	+	Rewa	+
Maharashtra	+	+	+	+	Maratwada	+	+	Western Mhr.	+	?	Konkan	?	+	Vidarbha	+	?	Bombay	?			

1	2	3	4	5	6	7	
Mysore	—	—	—	+	?	?	
	+	Bangalore	Hasan	Dharwar	Gulbarga	Mangalore	
	—	+	+	+	+	—	
Orissa	+	+	?	+	+		
	+	Cuttack	Balasore	Koraput	Sambalpur		
	+	+	?	+	?		
Punjab	+						
	+						
	+						
Haryana	+						
	+						
	+						
Rajasthan	+	+	*	*	*	*	?
	+	Ajmer	Jodhpur	Bikaner	Udaipur	Udaipur	Kota
	+	+	*	*	*	*	*
U.P.	+	*	*	*	+		
	+	Northern	Western	Eastern	Central		
	+	*	*	*	—		
W.B.	?						
	+						
	+						
Central Schools	+						
	+						
	+						
Public Schools	+						
	+						
	+						

+: Boys achievement greater than Girls achievement in both the test forms
—: Boys achievement less than Girls achievement in both the test forms
?: Boys achievement greater than Girls achievement in one form and the other way in the other form.
*: Number of girls in the sample is too small for comparison.

In Mysore state at the primary level girls scored better than boys in both the forms. The same trend could be seen at the high school level. Only at the middle the trend is in the expected direction viz. boys scoring better than girls.

The situation in Mysore State is quite interesting. At the high school level in four regions out of five the results are in the expected direction. In the fifth region viz. Mangalore region the mean score for the region is greater than the means of other regions and further the girls scored appreciably better than boys. The larger mean for girls boosted up the mean for the total state which resulted in the reversal trend at the level.

Results of Central Schools especially English medium and Public Schools reveal larger differences between boys and girls. It may be noted that these groups of schools cater to the upper middle class and well to do families and equal opportunities are provided to boys and girls in the pursuance of their studies. Most probably the cultural role expectations are contributing to these differences. This hypothesis needs further exploration.

It may also be seen that although in many cases the girls of a state group are lower in mathematics achievement than the boys of the same state/group there are a number of states/groups where the inferior girls are superior to the boys of other states.

Sex differences in other words are a 'within group' phenomenon. This again suggests the importance of the educational variables such as curriculum and methods of instruction etc. and environmental conditions, which can compensate for the variables like socio-economic status, sex etc.

11.2 Mathematics Achievement—Age

One of the student variables which can be related to mathematics achievement is the age of the student. Even though compulsory education is introduced, and it is mandatory on the part of parents to send their children to the schools after they attain a certain minimum age it is not always true that the students in a given class will belong to more or less the same age group. There are some differences between states regarding the age of entry to the school as well as the modal age group for a particular class. Modal age group refers to that age group to which the majority of the students belong. It may be of interest to know whether age of entry has got anything to do with students' achievement but this aspect was not studied in the present survey.

All the students were classified into four age groups at primary, middle and high school levels as shown in Table 11.3.

For comparing the mathematics achievement in relation to age, modal age group was taken as a reference point. A large proportion of students belonging to the higher age group come from those who have failed at one stage or other during their schooling. As such it was hypothesised that the performance of the modal age group would be better than that of the higher age groups.

TABLE 11.3

Age Group at Different Levels

Age *Level*	*Group 1*	*Group 2*	*Group 3*	*Group 4*
Primary	10 yrs. or below	11th yr.	12th yr.	13 yrs. or above
Middle	12 yrs. or below	13th yr.	14th yr.	15 yrs. or above
High	14 yrs. or below	15-16 yrs.	17-18 yrs.	19 yrs. or above

TABLE 11.4

Modal Age and Grades to which the Tests were Administered at Different Levels

	State/Group	*Primary*		*Middle*		*High*	
		Grade	*Modal age*	*Grade*	*Modal age*	*Grade*	*Modal age*
1.	Andhra Pradesh	VIb	10	IXb	14	XIf	15-16
2.	Assam	VIb	12	IXf	15+	XIb&Xf	15-16
3.	Delhi	Vf	10 or below	VIIIf	13	Xf	15-16
4.	Gujarat	VIb	11	IXb	15	XIf	17-18
5.	Jammu & Kashmir	VIb	12	IXb	14	Xf	17-18
6.	Kerala	VIb	12	IXb	15+	2nd yr. pre-degree b	17-18
7.	Madhya Pradesh	VIb	12	IXb	15+	Xf	15-16
8.	Maharashtra	VIb	11-12	IXb	15+	XIf	15-16
9.	Mysore	VIb	11	IXb	14	Xf	15-16
10	Orissa	VIb	11	IXb	14	XIf	15-16
11.	Punjab	VIb	12	IXb	15+	Xf	15-16
12.	Haryana	VIb	11-12	IXb	14	Xf	15-16
13.		VIb	12	IXb	15+	Xf	15-16
14.	Uttar Pradesh	VIb	12	IXb	14	Xf	15-16
15.	West Bengal	VIb	11	IXb	14	XIb&Xf	15-16
16.	Central Schools	VIb	11	IXb	14	Xf	15-16
17.	Public Schools	Vf	10 or below	VIIIf	13	Xf	15-16

b= Students who had just entered that grade.
f= Students who were at the end of the academic year.

Table 11.4 present the modal age groups for the three levels of testing in the different states. For ready reference and comparison purposes the grades taken for testing at the three levels are also to given in the same table.

One can see from Table 11.4 that the modal age group at the primary level is either 11 years or 12 years in all the states except in the case of Delhi and Public Schools in which case the modal age seems to be 10 years. However if we consider the class to which the primary level tests were administered it could be seen that while in all other states the tests were administered to VIth grade beginners, in case of Delhi and Punjab schools the tests were administered to Vth grade finishers.

At the middle level the modal age is either 14 years or 15 years except in the cases of Delhi and Public Schools in whose case it is 13 years. Here also the grade to which the middle level tests were administered explains the difference i.e. in Delhi & Public Schools VIII grade finishers were administered the tests while in other states IXth grade beginners were in the sample.

At the high school level the modal age group is 15-16 years in most of the states. The exceptions being Gujarat, Jammu & Kashmir and Kerala in whose case the modal age group is 17-18 years.

Table 11.5 presents the sample size, mean and standard deviations for different age groups at the three levels viz. primary, middle and high school levels. At the primary level, performance of the modal age group in 11 out of 18 states is in the expected direction viz. better than that of the higher age group (s). In the case of Kerala, Mysore and Haryana the direction is reversed. In the case of Gujarat, Jammu and Kashmir, Central Schools and Public schools no clear cut trend could be seen. The differences however are not large.

At the middle level for comparing the performance of the modal age group with higher age group (s) we have to consider only those states where modal age is less than 15 years. Out of these groups of schools in A.P. Delhi, Orissa, Haryana, Uttar Pradesh, West Bengal and Public schools the results show in the expected direction. In the case of Jammu and Kashmir, Mysore and Central Schools there is no clear cut trend. At the high school the results are in the expected direction in all the states except Jammu & Kashmir where in one of the two tests the result is in the reverse direction.

It may be noted that while making these comparisons the case of those age groups with smaller sample sizes were neglected. Careful scruitny of the Table 11.5 would reveal that the performance of lower age groups is better than that of modal age groups as well as the higher age groups in many states. This is expected as in the majority of such cases the students might be having lower age in a class because of promotions due to higher ability and or earlier age of entry due to better socio-economic condition etc. In the schools their performance level hence was expected to be slightly better than the remaining age groups.

TABLE 11.5

Mathematics Achievement of Different Age Groups

		Age group I			Age group II			Age group III			Age group IV		
State/Group	Test	n	m	s.d.	n	m	s.d.	n	m	s.d.	n	m	s.d.
1	2	3	4	5	5	7	8	9	10	11	12	13	14
1. Andhra Pradesh	P1	586	13.9	6.7	730	13.8	6.7	526	13.4	7.4	293	12.6	5.9
	P2	565	13.3	5.9	744	13.3	6.2	551	12.9	6’3	286	12.2	9.2
	M1	32	11.2	3.3	130	13.4	5.2	180	13.3	5.6	171	11.5	4.2
	M2	33	11.7	4.8	134	13.0	4.8	173	12.4	4.4	176	12.4	4.4
	H1	56	18.7	8.1	424	18.6	7.7	191	16.8	6.3	25	16.8	8.2
	H2	69	18.7	8.6	452	19.9	8.1	185	18.6	6.1	17	18.6	5.2
2. Assam	P1	39	24.8	7.8	47	25.0	7.4	75	22.6	9.2	44	22.0	8.9
	P2	41	23.0	8.2	59	22.9	7.1	64	22.3	8.9	48	21.4	6.6
	M1	6	13.3	6.8	15	14.5	6.4	61	17.1	8.7	94	14.5	7.0
	M2	3	6.0	5.6	18	18.1	8.1	63	18.3	9.0	92	16.1	7.2
	H1	12	15.0	5.7	256	18.1	9.3	125	18.2	8.2	10	14.9	5.6
	H2	21	18.4	8.4	238	19.5	8.9	122	17.7	7.6	5	21.2	7.6
3. Delhi	P1	295	25.1	9.4	133	22.9	9.5	82	23.7	10.7	40	19.9	8.5
	P2	320	24.7	9.1	141	23.8	8.7	87	23.2	8.8	41	22.0	9.1
	M1	71	20.4	9.8	179	17.5	9.0	150	17.4	8.3	164	15.8	7.7
	M2	85	19.0	9.1	161	18.7	9.8	140	18.1	10.2	171	16.2	5.8
	H1	44	26.1	11.2	317	24.3	9.9	55	21.4	7.7	6	18.0	8.0
	H2	45	25.5	8.2	322	23.8	10.0	63	22.9	7.0	6	18.0	5.3

1	2	3	4	5	6	7	8	9	10	11	12	13	14
4. Gujarat	P1	247	21.8	8.1	645	21.0	7.8	563	20.7	8.0	457	21.5	9.5
	P2	234	20.2	7.3	657	20.3	7.3	554	19.9	8.2	448	19.4	8.2
	M1	6	24.6	10.5	50	17.2	7.2	124	17.9	7.2	302	17.2	7.6
	M2	6	17.3	4.5	39	17.9	7.1	106	16.8	5.8	286	16.6	5.8
	H1	4	21.5	6.1	145	25.6	10.8	174	24.2	9.9	15	23.1	7.8
	H2	4	31.7	5.4	148	24.9	10.0	161	22.9	7.8	17	19.3	8.2
5. J & K	P1	37	14.9	6.4	36	14.9	7.0	61	14.7	5.5	23	13.8	5.31
	P2	27	13.5	5.6	51	15.5	8.6	51	14.7	6.5	26	15.5	7.0
	M1	5	15.2	7.8	21	13.9	5.5	41	14.8	8.0	69	11.6	6.2
	M2	7	12.1	10.1	26	12.7	7.5	50	11.6	4.8	51	14.2	7.1
	H1	9	18.1	5.7	89	18.3	6.2	91	17.8	5.6	28	18.8	4.7
	H2	9	17.7	4.8	78	19.0	5.5	89	18.3	5.0	42	18.2	5.1
6. Kerala	P1	213	22.0	6.8	387	21.6	6.7	400	20.7	6.2	531	21.4	6.8
	P2	205	20.5	6.7	421	20.7	5.7	410	20.4	6.1	494	21.2	6.0
	M1	6	9.0	5.7	34	16.1	7.4	70	15.7	6.4	196	17.0	13.5
	M2	1	13.0	—	31	16.8	6.0	82	16.9	6.0	200	17.1	6.0
	H1	1	24.0	—	260	30.4	8.0	357	28.5	8.5	66	28.0	6.6
	H2	1	24.0	—	124	28.9	9.1	137	26.1	6.5	23	23.9	6.2
7. Madhya Pradesh	P1	153	17.6	8.1	256	18.6	8.9	284	16.9	7.9	222	16.0	4.1
	P2	164	17.1	7.3	247	16.6	8.4	264	15.3	6.8	236	14.4	6.5
	M1	41	16.3	9.3	129	16.0	7.8	182	15.9	7.7	304	14.0	6.5
	M2	47	17.2	6.8	115	16.1	5.5	204	14.8	6.2	271	13.4	5.4
	H1	200	20.0	8.1	788	18.5	7.3	445	17.1	6.7	64	17.0	4.1
	H2	190	21.7	10.7	772	20.4	8.9	376	18.3	6.7	61	16.1	6.5

1	2	3	4	5	6	7	8	9	10	11	12	13	14
8. Maharashtra	P1	212	21.2	9.5	367	20.7	7.9	336	19.8	7.7	318	18.5	7.1
	P2	224	22.2	9.2	348	20.5	7.9	365	19.6	7.2	265	19.6	7.2
	M1	137	19.4	8.9	552	19.9	9.3	931	17.4	7.6	1466	15.9	6.7
	M2	141	19.0	9.4	543	18.4	8.6	884	17.0	10.5	1496	15.7	8.2
	H1	23	26.1	10.8	268	23.8	11.2	193	22.3	10.3	50	19.3	12.8
	H2	19	24.8	7.5	266	24.3	11.6	184	22.6	9.4	30	18.7	9.9
9. Mysore	P1	558	18.1	8.4	700	19.1	9.0	624	19.7	9.7	304	19.0	10.4
	P2	583	18.1	8.0	684	18.1	8.4	591	19.4	9.9	327	19.0	7.4
	M1	52	16.6	8.4	162	16.1	7.3	217	16.8	8.4	251	16.9	8.1
	M2	49	15.9	9.5	155	15.1	7.7	189	17.1	8.7	264	15.7	8.5
	H1	183	14.9	4.3	695	16.7	4.6	279	16.3	4.5	51	14.8	4.4
	H2	188	18.5	4.9	876	19.3	5.0	293	17.9	4.8	43	17.5	4.8
10. Orissa	P1	119	23.7	9.0	142	22.4	7.7	109	20.7	8.0	65	20.9	9.7
	P2	116	23.0	8.3	125	21.1	7.4	116	20.9	7.9	81	19.1	7.3
	M1	77	20.3	7.6	345	20.4	9.2	503	20.0	9.0	496	19.3	9.1
	M2	68	20.8	10.1	359	19.8	8.9	483	18.6	9.0	485	18.4	8.6
	H1	50	28.5	10.5	526	28.3	10.1	350	24.8	10.6	31	19.4	9.8
	H2	40	27.3	10.2	523	28.0	10.3	368	25.4	10.0	22	23.5	7.3
11. Punjab	P1	26	17.4	6.3	84	19.1	7.5	135	17.2	6.6	68	14.8	5.2
	P2	34	17.2	5.6	82	17.1	6.7	137	17.5	6.4	63	16.8	6.5
	M1	2	14.0	2.8	39	16.7	6.6	90	19.1	9.7	184	16.7	7.1
	M2	4	19.5	7.0	39	18.5	8.5	108	15.9	6.4	163	15.6	7.6
	H1	27	22.3	10.1	385	19.7	7.8	188	17.9	6.5	17	18.8	8.2
	H2	39	21.1	8.6	379	21.6	7.4	177	21.1	6.3	24	19.8	7.3

1	2	3	4	5	6	7	8	9	10	11	12	13	14
12. Haryana	P1	18	18.0	10.7	44	18.3	7.4	46	18.4	8.1	27	20.2	8.6
	P2	16	12.9	4.3	47	17.0	7.2	46	18.6	7.9	26	17.8	8.5
	M1	77	15.4	4.2	11	17.6	8.2	54	17.4	8.5	70	15.8	6.7
	M2	70	14.0	6.2	14	17.0	7.3	44	16.0	9.1	77	15.8	8.1
	H1	18	20.9	5.9	132	20.9	7.9	46	19.5	6.6	4	21.3	3.0
	H2	14	23.4	4.1	141	23.8	8.0	40	19.5	6.3	—	—	—
13. Rajasthan	P1	49	16.7	6.2	88	17.3	6.1	118	16.9	6.4	140	15.5	7.1
	P2	48	16.4	7.9	73	17.2	7.9	139	16.6	6.5	122	15.6	6.1
	M1	21	18.6	6.6	187	17.2	8.0	479	17.6	8.9	971	17.0	8.6
	M2	30	17.2	6.2	134	16.9	6.7	532	16.2	6.6	956	15.9	6.9
	H1	7	16.7	6.9	204	20.6	7.9	128	19.2	7.6	14	17.1	7.9
	H2	10	23.5	5.2	188	21.6	7.0	137	19.0	6.4	12	17.6	4.0
14. Uttar Pradesh	P1	381	17.7	8.2	406	18.7	8.6	441	18.1	8.0	255	17.2	8.7
	P2	410	17.3	7.8	462	17.4	7.8	405	18.0	8.3	206	17.2	8.1
	M1	71	16.7	8.1	132	16.8	8.4	207	17.1	7.7	209	15.5	7.4
	M2	71	15.1	5.4	136	18.4	9.5	211	17.0	7.5	203	17.4	8.1
	H1	87	18.8	8.8	259	17.5	7.7	90	16.8	10.1	8	21.4	11.1
	H2	77	20.2	9.2	245	19.6	8.9	101	18.2	9.2	6	18.8	7.1
15. West Bengal	P1	71	24.8	8.1	86	24.1	8.3	35	21.3	7.7	27	19.1	7.3
	P2	86	22.3	7.2	75	21.4	6.5	35	20.2	7.5	25	18.8	6.6
	M1	21	22.7	10.3	84	24.4	12.9	127	21.0	12.1	73	16.6	10.0
	M2	26	22.1	13.3	76	23.0	11.8	102	15.5	13.6	66	15.5	12.6
	H1	69	26.6	13.4	344	28.1	12.6	92	21.3	9.6	3	16.7	3.4
	H2	70	24.5	13.7	320	27.7	12.8	93	22.0	10.4	1	24.0	—

1	2	3	4	5	6	7	8	9	10	11	12	13	14
16. Central Schools (English)	P1	68	23.6	8.9	70	22.5	6.8	24	22.5	10.2	11	22.6	8.6
	P2	60	21.5	7.4	52	22.1	6.5	36	24.0	8.0	11	20.7	6.3
	M1	3	17.7	5.5	23	13.8	5.7	28	14.9	7.0	25	14.6	5.9
	M2	1	32.0	—	17	16.0	6.8	24	14.4	5.7	26	16.4	7.5
	H1	62	20.0	9.3	205	20.4	9.5	33	18.1	5.7	1	11.0	—
	H2	79	22.8	10.3	223	22.2	9.5	41	18.7	7.3	4	24.0	5.2
17. Central Schools (Hindi)	P1	46	19.3	8.3	51	17.0	6.5	31	15.7	5.6	9	19.6	6.5
	P2	40	18.4	7.0	55	17.2	7.1	25	15.1	5.9	16	17.8	4.5
	M1	3	17.7	5.5	23	13.8	5.7	28	14.9	7.0	25	14.6	5.9
	M2	1	32.0	—	17	16.0	6.8	24	14.4	5.7	26	16.4	7.5
	H1	12	15.5	3.9	77	17.5	6.2	21	15.8	4.2	1	35.0	—
	H2	11	17.6	4.5	77	18.9	6.7	24	16.2	5.6	3	14.7	2.1
18. Public Schools (Hindi)	P1	37	26.3	7.1	23	23.3	8.1	8	25.1	10.7	2	29.5	10.6
	P2	50	24.0	7.9	15	25.7	8.4	6	28.0	9.1	4	33.5	10.1
	M1	3	33.0	10.6	47	29.0	11.0	25	27.5	11.6	5	23.4	9.3
	M2	7	23.7	8.3	50	28.1	10.4	18	24.0	7.2	5	19.0	6.4
	H1	8	31.3	7.8	72	31.8	13.5	1	14.0	—	1	24.0	—
	H2	8	32.8	8.3	63	32.1	11.2	6	26.5	11.8	—	—	—

Similar results were found in I.E.A. study also. Two of the target populations which are relevant for the age variable in that study are:

Population lb: All pupils at the grade level where the majority of pupils of age 13 years 11 months old are found.

Population 3a : Those studying mathematics as an integral part of their course for their future training or as a part of their pre-university studies.

Population 3b: Those studying mathematics as complementary part of their studies and the remainder.

The results suggest that for the populations 1b and 3a increased age is associated with increased score, but the reverse is true for population 3b. The results further suggest that the important variable is not age of entry but what is done to the students after they enter in the school.

CHAPTER XII

MATHEMATICS ACHIEVEMENT AS RELATED TO ATTITUDE AND OTHER STUDENT-PARENT VARIABLES

12.1 Student Questionnaire

12.11 *Introduction:* In the previous chapters results indicating the relation between student variables—sex and age with mathematics achievement were described. But in addition to these there are many other variables (e.g. students attitude towards mathematics, their teachers, the facilities etc.) which might have a greater impact on their learning process itself and therefore on their performance. Recently two studies were conducted in India in this direction. In one study (C.S. Bennur 1967), five criteria had been considered to decide the socio-economic status of the families the students came from. They were (1) Occupation (2) Income (3) Formal education (4) Subscription to newspaper and (5) Possession of radio. It has been concluded that pupils of different socio-economic status differ significantly from each other in their academic achievement. In another study B.R. Patil (1967) concluded that if students are interested in a particular subject their achievement will be better and vice-versa.

In the I.E.A. study also detailed questionnaires were prepared to get information about socio-economic background, home, environment, school environment and the attitudes of students.

Unfortunately in India there are no standardised tools to collect information on socio-economic conditions and attitudes. To develop such tools in all regional languages for MAS project and to collect reliable data on these variables at all the three levels of education was considered a rather time-consuming and costly affair. It was hence decided to collect such data only through a questionnaire addressed to the students taking high school tests with all the limitations such a tool imposes on the reliability or validity of the data. Considering the limitations of time and resources it was decided to develop the questionnaire in English and Hindi only and adminisi it to er the high school students (those taking the high school level tests). Considering the coding and punching difficulties the questionnaire was not translated into other 'regional languages on the assumption that these high school students can understand or be made to understand the questionnaire in English/Hindi'.

This questionnaire attempted to collect information on the following variables:

1. Socio-economic status
2. Parents' education
3. Students' perception about their own performance in the subject
4. Facilities provided for studying
5. Students' attitude towards:-
    a) mathematics as a process
    b) role of mathematics in the modern civilisation
    (c) school education in general and mathematics teachers in particular.

Before this questionnaire was administered to the high school students an opportunity arose to try it out for middle level students in Orissa. (G.S. Paikaray, 1967). The questionnaire (excluding some items) was translated into Oriya by Paikaray and was administered to a sample of middle schools of Orissa. Along with it a Teacher's Questionnaire—to collect data on teacher variables—his qualifications, experience etc. was also administered. Relevant findings of this study—later on to be referred to as Orissa Study—are reported along with MAS project findings in the subsequent sections.

12.12 *Sample Chosen for Analysis:* Although the questionnaire was administered to all the students taking high school tests from all the states which participated in the survey, not all the data was analysed. Due to shortage of availability of computer time, it was decided to analyse data only from Haryana, Gujarat and Central Schools. For the same reason no sophisticated analysis (e.g. multivariate analysis) was undertaken. The results are hence to be interpreted more for consistent trends rather than for specific quantitative differences.

The sample sizes of the students in the three groups of schools is given in Table 12.1. The figures in the brackets indicate the number of schools for which an Attitude Study was conducted.

TABLE 12.1

Sample Chosen for Attitude Study

Group	*Test Form* *H*1	*H*2	*Total sample*
1. Haryana	200	195	395 (14)
2. Central Schools	301	317	618 (33)
3. Gujarat	338	330	668* (66)

* Sub-sampling of answer scripts was resorted to in Gujarat State at the analysis stage.

12.13 *Orissa Sample:* In the Orissa Study, a sub-sample of 25 schools was drawn out of the sample of 90 schools selected in Orissa state where MAS tests at middle level were administered.

Out of these 16 schools provided complete data on the two questionnaires —one for students and another for teachers. From these schools 398 students from grade IX (beginners) participated in the study. Scores obtained by these students in the middle school certificate examination were also collected.

12.2 Parental Variables

12.21 *Socio-economic Index vs. Mathematics Achievement:* One of the intriguing aspects of students' achievement is the socio-economic status of their parents. Many studies do not show any correlations between these two variables even though some of these studies suggest selectivity bias viz. larger proportions of students from upper middle classes and higher class pursue higher studies and obtain admissions in the many professional courses. In the MAS project socio-economic index of a student was calculated on the basis of his/her fathers' occupation, income, parents' education and availability of resources (Q. Nos 8, 9,10, 11 and 12). The socio-economic index, thus calculated, was then correlated with mathematics achievement.

These correlations are given in Table 12.2.

TABLE 12.2

Mathematics Achievement and Socio-economic Status

Group	*Form*	*Sample Size*	*Socio-economic Score*		*Math. Ach. Score*		*Correlations*
			m	*sd*	*m*	*sd*	
Haryana	1	200	7.86	3.5	21.79	7.6	—.0182
	2	195	7.56	2.9	22.78	7.9	.1465
Central Schools	1	301	11.14	4.6	20.07	9.1	.2570
	2	317	10.76	4.3	22.08	9.5	.3231
Gujarat	1	338	8.07	3.2	24.94	10.3	.0603
	2	330	7.98	2.8	23.71	9.1	.1418

Considering mean scores on socio-economic index in Table. 12.2, the students of Central Schools alone seem to come from higher socio-economic group. The scatter is also wider in Central Schools. In Gujarat and Haryana the mean is lower and the scatter narrower. It might be that because of this only in Central Schools a positive but low correlation is obtained while in the states of Haryana and Gujarat the correlations are not significantly different from zero.

In the Orissa Study also low correlatios were obtained. This only suggests that below a certain level the marginal differences in socio-economic

TABLE 12.3

Mathematics Achievement — Father's Occupation

Group	*Form*	*Professional & Technical*				*Administrative & Executive*				*Business*				*Farming*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Haryana	I	20.66	9.3	9	3%	20.96	9.6	31	15%	23.00	7.1	40	21%	22.00	7.0	69	33%
	II	18.00	0.0	1		26.48	8.7	29		26.48	8.7	29		22.33	7.6	63	
Central Schools	I	26.26	11.1	19	6%	22.93	9.2	66	22%	19.83	8.4	31	11%	15.80	6.1	4	2%
	II	26.95	13.5	21		26.16	8.1	68		23.75	12.7	36		21.54	5.3	11	
Gujarat	I	24.70	12.8	10	2%	26.18	11.6	50	17%	25.13	10.3	105	27%	24.40	9.6	94	29%
	II	37.75	13.1	4		24.27	10.2	66		24.30	9.1	75		23.50	8.8	103	

		Skilled				*Unskilled*				*Defence*				*Teaching Profession*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
		19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34
		20.12	3.7	8	7%	20.28	7.1	14	6%	23.25	8,5	4	41%	22.33	8.2	21	8%
		23.09	4.8	21		16.55	5.0	9		24.50	5.2	10		23.50	6.9	10	
		23.05	10.5	20	6%	17.70	6.5	10	2%	18.10	7.7	110	36%	26.81	13.3	11	3%
		23.31	11.7	16		22.80	3.0	5		20.28	7.7	113		40.60	14.6	5	
		23.31	9.6	22	7%	24.66	4.9	3	1%	23.33	7.0	3	1%	28.41	10.1	17	4%
		22.50	8.0	22		22.00	9.8	4		21.50	12.0	2		26.45	6.8	11	

conditions as such cannot contribute to the educational achievement of the children. In view of this low correlation between the overall socio-economic index and mathematics achievement it was decided to probe further into some of the individual variables which were included in the composite of socio-economic index. These are discussed in the subsequent sections.

12.22 *Father's Occupation:* An open-end question was asked in the questionnaire (Q. No. 8) regarding father's occupation. The information was later on coded for further analysis. For this purpose these occupations are categorised into nine groups as follows:

1. Professional and technical
2. Administrative, executive, managerial and clerical
3. Business
4. Farmers, fishermen, milkmen etc.
5. Skilled workmen
6. Unskilled workmen
7. Defence services
8. Teaching profession
9. Social service

Further break-up of occupations into sub-categories depending upon occupational level was also considered at the time of coding and the detailed break-up of occupational categories given in Appendix 12.1.

Table 12.3 gives break-up of the sample over occupations and Table 12.4 gives the break-up of the sample over occupational levels. These tables also present means and standard deviations on mathematics achievement tests.

TABLE 12.4

Mathematics Achievement—Father's Level of Occupation

Group	*Form*	*Low*				*Middle*				*High*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*n*	*s.d.*	*n*	*sampl*
Haryana	I	21.63	7.4	72	37%	22.13	7.6	112	57%	20.06	8.7	16	6%
	II	22.68	8.5	76		23.08	7.2	112		23.00	5.1	7	
Central Schools	I	17.74	7.9	111	41%	20.76	8.6	112	38%	23.48	10.7	68	21%
	II	18.84	7.6	144		23.20	9.8	110		27.08	11.6	62	
Gujarat	I	24.36	11.4	130	37%	25.44	9.4	119	61%	23.11	13.7	9	2%
	II	22.98	9.0	120		23.94	8.9	206		35.75	15.8	4	

In Haryana State in the sample father's occupation in majority of the cases is Farming (33%) followed by Business (21%) and Administrative (15%). In the Central Schools for 36% father's occuaption is Defence Services followed by 22% Administrative and 11% Business while in Gujarat the break-up is 29% Farming, 27% Business and 17% Administrative. As regards the mathematics achievement the results do not reveal any clear cut trend in favor of a particular occupation across groups.

The results in Table 12.4 reveal that in the Central Schools larger number of students (21%) belong to higher level occupational group as compared to Haryana (6%) and Gujarat (2%). However the majority belong to lower level occupational group (41%) followed closely by middle level group (37%) while in the case of Haryana and Gujarat majority belong to middle level occupational group 57% and 61% respectively followed by lower level occupational group with 37% in each of these two states.

In the case of Central Schools, level of fathers' occupation has got definite influence on the performance of students. The differences in the means of higher level occupations and lower level occupations are appreciable. The same cannot be said in cases of Haryana and Gujarat. However the samples being small in these two cases for the higher level occupations (only 6% and 2% respectively) we may only consider the first two levels of occupations viz. lower and middle levels. Restricting to these levels in the case of Haryana and Gujarat the means obtained for middle level occupations are slightly greater than those for lower level occupations. This suggests that further research in this direction is needed with a bigger sample from each of the occupational categories and belonging to different levels within an occupation. Possibly a two way analysis for occupation and level of occupation may throw more light on the influence of father's occupation on the performance of their children.

12.23 *Parent's Education:* Many research studies revealed that the parental education has got some influence on the performance of their children. Table 12.5 and 12.6 give the results relating mathematics achievement to parental education.

Only in Central Schools parents are more educated as compared to Haryana and Gujarat. Even though it was expected that the higher the education of parents the higher would be the achievement of their children no such trends could be seen from these results—possibly because the tests are too difficult.

In the Orissa Study also no such trends could be observed. In the IEA study regression analysis was done and it was found that parental variables make a large contribution to total variance. In general it was found that the status of the "Father's Occupation" is the most powerful out of the group of variables, "Father's Education" and "Mother's Education" taking the second and third places. As mentioned earlier the MAS Project does not show much impact of father's occupational status or parents education on the performance of their wards. This prompts one to ask the question whether Indian parents differ from their western counterparts in their behaviour towards their wards e.g. in helping them in their studies, providing more learning facilities etc? It is generally agreed that parents in India have not reached that state to understand and appreciate the educational

TABLE 12.5

Mathematics Achievement—Father's Education

Group	Test Form	Illiterate				Primary				High School				College			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.69	7.5	52	28%	21.40	6.2	54	27%	23.35	8.9	56	28%	19.73	7.1	34	16%
	II	22.24	7.2	58		22.92	7.8	51		24.11	7.5	53		23.25	7.6	28	
Central Schools	I	19.20	6.3	10	3%	17.85	8.0	21	7%	20.21	9.1	96	33%	21.08	9.3	159	50%
	II	26.71	9.6	7		19.58	9.6	24		20.69	8.2	111		23.95	10.6	150	
Gujarat	I	22.86	7.4	37	11%	25.18	10.2	171	50%	23.98	10.1	81	27%	28.59	12.3	44	11%
	II	22.44	9.9	34		23.79	8.8	160		23.15	8.5	99		26.25	11.7	32	

TABLE 12.6

Mathematics Achievement—Mother's Education

Group	Test Form	Illiterate				Primary				High School				College			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.77	7.6	119	61%	21.94	7.8	55	24%	20.89	7.0	19	11%	23.50	14.8	2	1%
	II	23.30	7.8	122		23.23	6.8	39		22.64	6.7	25		25.00	—		
Central Schools	I	18.57	6.1	35	11%	20.18	7.5	79	26%	21.18	10.4	127	42%	21.87	9.5	41	13%
	II	19.78	5.9	33		21.34	10.3	83		22.00	9.9	32		27.24	10.5	41	
Gujarat	I	25.49	9.7	108	31%	24.27	10.5	189	56%	28.15	10.3	32	10%	21.85	11.3	7	1%
	II	23.40	7.9	96		23.68	9.4	128		24.32	9.8	34		38.33	15.6	3	

needs of their children and pay attention to them, within the limitations of the family income or educational background. However lately certain groups in the Indian society are gradually becoming aware of the role of parents. This is confirmed to some extent by the performance in Central Schools. –

12.24 *Teacher Variables:* In the MAS project no attempt was made to study teacher variables and their influence on the performance of students. However in the Orissa study a separate questionnaire was also administered.

Teacher's Qualifications: Rank order correlation was found between the teacher's qualifications and mean achievement in mathematics tests in the schools were considered. The correlation was found to be .08. Similarly rank correlation between teacher's experience and mean achievement was calculated and was found to be .07.

These results do not show any relationship between school performance and teacher's qualifications and experience. However it is erroneous to conclude that a teacher without any qualifications will make his students achieve the same as the teacher with qualifications. Generally for teaching mathematics teachers with mathematics as subject at graduate or undergraduate level are appointed. But experience and qualifications of teachers alone cannot determine the pupils' achievement.

In the IEA study about seven teacher variables such as qualifications, training, sex etc. were considered. Even though findings indicate some relationship of these variables with mathematics achivement these are quite inconsistent across countries. Some of the interesting findings are: (i) In general, the data seem to support the hypothesis that the more training a teacher has received, the better will be achievement of his students, but this does not hold in all cases. (ii) On the sex of teachers the study suggests that men are better mathematicians and the women are better teachers.

12.25 *School Variables:* No information on schools could be collected in the M.A.S. Study except their location & management type. One piece of information indicating school standard was obtained through the student questionnaire by asking them regarding the percentage of marks they get in the school examination. (Refer to Table 12.7 on page 137).

(Q. 19) What percentage of marks do you usually get in the school mathematics?

The table reveals that high percentage of the students in the sample claim that they usually get more marks in mathematics tests. Even though these high percentages suggest that the students may be exaggerating a little bit about their performance these categorisations are sufficient to put the students on a five-point scale as regards their class performance in mathematics. The mean achievement on MAS tests seems to be highly correlated with the performance of the students in the classes. Actually those students who claim they get more than 75% marks in classroom tests got relatively higher mean on MAS tests, (however their mean on MAS tests was less than 50%.) These mean percentages on MAS tests are quite below the mean scores they obtained in the classroom. This may indicate that although the students who get higher marks on classroom tests also get higher marks on MAS tests, they fail on many of the items reflecting higher educational objectives because they are not exposed to these kinds of items in the classroom tests.

In the IEA project about 10 school variables such as school size, type of school, number of teachers etc. were considered with mathematics achievement. These school variables give generally small and inconsistent relationships from country to country. Only in a few cases moderate correlations were found, that too in a few countries. Some of the findings of IEA study on school variables relevant to Indian situation are: (i) In the majority of the cases size of class is not related to mathematics achievement (ii) Specialisation in the sense of restricting the number of subjects in the pre-university year, is not necessarily associated with higher scores in mathematics (ii) Financial support does not appear to be a major factor associated with student achievement in mathematics.

12.3 Student Variables—Expectations, Aspirations, etc.

12.31 *Expectations and Aspirations of the Students:* There were three questions to elicit information regarding expectations and aspirations of students about their future career.

(Q: 13) If enough money is given and you go to college, will you be able to get a degree in a high class or a good division?

TABLE 12.8

Group	*Test Form*	*Yes*				*No*			
		m	*s. d.*	*n*	*sample*	*m*	*s. d.*	*n*	*sample*
Haryana	I	21.91	7.6	181	88%	20.91	7.6	18	10%
	II	23.08	7.4	167		22.43	9.6	23	
Central Schools	I	20.94	9.6	238	78%	17.05	5.5	40	14%
	II	22.84	10.3	243		18.97	7.8	44	
Gujarat	I	25.83	10.3	288	87%	18.87	7.4	41	11%
	II	24.23	9.2	293		19.15	7.5	32	

Thus it is quite encouraging to see that the majority of the students, 88% in Haryana, 78% in Central Schools and 87% in Gujarat feel that if enough monetary facilities are provided to them they hope to get a good class in the college. Further the performance of these students is better than those who are not confident of getting a good class even if these monetary facilities are provided to them.

As regards their higher studies what do our students want to pursue as their subjects at university degree? The following question briefly summarises their likings:

TABLE 12.7

Mathematics Achievement—School Performance

Group	*Test Form*	75% or more				60%—74%				45%—59%				33%—44%				32%—or less			
		m	*s.d.*	*n*	*sample %*	*m*	*s.d.*	*n*	*sample %*	*m*	*s.d.*	*n*	*sample %*	*m*	*s.d.*	*n*	*sanmple %*	*m*	*s.d.*	*n*	*sample %*
Haryana	I	26.38	9.6	57	29%	21.72	5.7	69	35%	17.96	5.4	64	29%	22.28	5.4	7	5%	16.33	2.3	3	1%
	II	26.08	9.1	60		23.08	7.2	69		20.05	5.4	53		19.09	4.6	11		16.00	3.5	2	
Central Schools	I	23.43	9.9	41	16%	21.94	10.1	84	27%	19.21	9.2	92	30%	17.84	6.0	53	16%	16.9	7.0	31	11%
	II	27.96	12.4	59		21.66	8.1	81		21.44	8.3	92		19.16	8.6	48		19.0	10.2	37	
Gujarat	I	32.47	21.2	65	18%	26.22	8.6	99	28%	22.07	8.9	92	29%	21.78	8.8	57	18%	18.00	7.2	26	7%
	II	31.59	12.1	54		24.91	7.4	91		22.01	7.1	103		19.39	6.6	61		19.09	8.42	1	

(Q. 14) Which of the following subjects would you like to study for your final university degree? (Refer to Table 12.9)

Most of the students prefer to go for Engineering, 41% in Haryana, 32% in C.S. and 26% in Gujarat, closely followed by Physical Sciences 27%, 21% and 21% respectively for these groups. Next comes Biological and Medical Sciences. Very few students wish to opt for Education. Considering the performance of the students for these subjects those people who would like to opt for subjects which will lead them to professional courses scored better than those in Social Sciences.

Students who wish to chose Mathematics or Statistics at University level those even though a smaller number comparatively, performed better than those who would like to opt for social science. These results show that students who have already set goals before them for studying professional courses show better performance.

In the IEA study the findings reveal that the students who plan or have aspirations for higher education perform better on the mathematics achievement tests than those who do not have any such plans or aspirations.

What about their future aspirations after completing their studies. Data collected on the following question gives this information.

(Q. 15) After finishing your education what occupation do you expect to get into? (Refer to Table 12.10)

The table shows the broad categories of occupations which the students would expect to get into. Some students also preferred occupations like Farming, Skilled etc. but their numbers are too small to report, further there were some non responses especially in the case of Central Schools. Most of the students prefer Technical and Professional occupations (52% in Haryana, 57% in Central Schools and 37% in Gujarat). The performance of these students is compartively better than the students who expect to get into other occupations.

12.32 *Availability of Resources and Facilities:* There are two questions to elicit information regarding whether the students are required to seek jobs before they go on to college education and whether mathematics books other than textbooks are available to them for reading.

(Q. 21) If you want to read can you get books on Mathematics other than the textbooks? (Yes) (No)

Only few students (2% in Haryana, 7% in Central Schools and 2% in Gujarat) reported that their parents ask them to get into employment before they go for college education while the majority of the students were not required to support their family before they seek college education. As the number of students in the first category is too small no comparison in their performance was made. (Refer to Table 12.11)

How about the reading material?

The results reveal that only 33% in Haryana and 49% in Gujarat stat

TABLE 12.9

Mathematics Achievement—Subject of Interest

Group	Test Form	Physical Sciences				Biological & Medical Science				Engineering				Mathematics Statistics				Social Sciences, including Language, Education etc.			
		m	s.d.	n	sample %	m	s.d.	n	sample %	m	s.d.	n	sample %	m	s.d.	n	sample %	m	s.d.	n	sample %
Haryana	I	22.36	8.8	50	27%	20.45	4.8	22	11%	23.31	7.6	91	41%	19.12	4.9	8	5%	18.84	4.7	26	13%
	II	22.83	8.4	59		20.71	6.2	21		25.09	6.7	73		21.58	5.2	12		21.39	7.6	25	
Central Schools	I	21.26	10.5	64	21%	18.31	8.5	70	22%	22.75	8.4	95	32%	22.30	10.6	20	6%	16.25	5.8	35	11%
	II	21.90	7.9	66		19.31	8.7	69		26.13	11.3	105		25.94	7.4	18		15.68	5.4	35	
Gujarat	I	26.98	11.6	64	21%	27.30	10.7	55	15%	28.38	10.5	87	26%	22.17	8.9	29	8%	20.27	6.8	83	23%
	II	23.71	7.2	77		25.72	9.7	44		26.46	10.8	88		23.62	9.7	24		21.05	7.2	73	

TABLE 12.10

Group	Test Form	Professional & Technical				Administrative				Business				Defence Service				Teaching Profession			
		m	s.d	n	sample %	m	s.d	n	sample %	m	s.d	n	sample %	m	s,d	n	sample %	m	s.d.	n	sample %
Haryana	I	22.16	8.4	112	52%	21.05	6.2	39	24%	27.00	0.0	2	—	22.92	7.0	14	7%	22.44	7.6	18	10%
	II	23.53	8.7	94		21.12	5.5	54		.—				23.20	5.1	15		22.80	7.8	21	
Central Schools	I	20.98	9.3	174	57%	16.81	7.3	11	7%	17.00	9.3	4	2%	19.71	9.5	46	15%	18.47	8.1	19	5%
	II	23.58	10.4	178		19.95	6.6	24		20.62	13.1	8		21.51	9.8	45		18.90	9.6	11	
Gujarat	I	28.33	11.2	1292	7%	24.17	9.2	86	27%	22.83	7.7	30	7%	29.30	5.7	5	1%	21.47	8.0	46	41%
	II	26.23	9.3	118		22.79	9.6	93		21.21	8.4	19		27.50	5.5	2		22.21	8.6	47	

TABLE 12.11

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.25	5.4	2	2%	21.82	7.2	146	77%
	II	14.80	10.9	5		23.72	7.5	157	
Central School	I	17.37	10.7	16	7%	20.75	9.3	241	79%
	II	16.64	6.9	25		22.37	10.4	248	
Gujarat	I	21.00	5.4	4	2%	25.48	10.5	227	68%
	II	21.71	4.1	7		24.23	9.9	230	

TABLE 12.12

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.87	7.1	64	33%	21.82	8.2	115	55%
	II	22.47	6.5	68		23.99	8.4	102	
Central Schools	I	21.54	9.2	184	61%	17.85	8.2	88	29%
	II	24.05	10.8	191		19.82	6.8	94	
Gujarat	I	24.52	9.8	203	49%	24.14	9.5	206	48%
	II	24.29	11.1	126		23.02	9.8	112	

can get books on mathematics other than the textbooks while in Central Schools a good number of students, about 61% could get such books. The performance of those students who could get books to read is better than their counter parts in all the three groups of schools—except in the case of Haryana in one test form. (Refer to Table 12.12)

These differences in achievement are quite large in the case of Central Schools.

12.33. *Extra Help or Coaching in Learning Mathematics:* One question was included in the questionnaire to elicit information as to how many students receive extra help and the source of such help.

(Q.17) Apart from the studies in Mathematics at school, in the classroom or for homework, do you get any other help in learning Mathematics?

The table reveals that a majority of the students are not getting extra help. Only 31% in Haryana, 37% in Central Schools and 30% in Gujarat get extra help. As regards the performance no consistent trends could be seen. (Refer to table 12.13)

Of the students who receive extra help or coaching, majority of them take help from their parents or friends, 66% in Haryana, 78% and 47% in Gujarat. But there is a considerable large number of students 34% in Gujarat

TABLE 12.14

Group	*Test Form*	*Parents & Friends*				*Special classes organised by schools*				*Coaching class or tuition outside home or school*			
		m	*s.d.*	*n*	*sample %*	*m*	*s.d.*	*n*	*sample %*	*m*	*s.d.*	*n*	*sample %*
Haryana	I	21.71	6.1	46	66%	28.90	10.3	11	15%	23.50	7.8	6	14%
	II	23.08	9.7	35		19.57	4.6	7		23.20	6.5	10	
Central Schools	I	19.06	8.1	87	78%	17.85	5.4	7	5%	18.40	9.4	14	8%
	II	20.08	7.9	90		24.00	8.0	4		23.42	8.8	19	
Gujarat	I	24.94	9.4	53	47%	21.00	8.1	8	8%	23.90	6.8	30	34%
	II	23.75	8.0	40		23.87	14.6	8		25.00	9.2	38	

TABLE 12.13

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.86	7.6	65	31%	21.48	7.4	122	63%
	II	22.40	8.7	57		23.35	7.1	128	
Central Schools	I	19.07	8.1	110	37%	21.31	9.6	172	55%
	II	20.41	7.8	116		23.85	11.1	169	
Gujarat	I	24.49	9.2	102	30%	25.44	10.8	228	67%
	II	23.97	9.1	96		23.42	9.1	216	

who receive coaching from outside home or school (Refer to table 12.14). The means do not show any consistent trends to warrant any statement as to which type of coaching or extra help really increases the students' performance.

Further it may be pointed out here that some intelligent students may not go for any coaching and it cannot be definitely said that all students who go for coaching or extra help are not intelligent. As such the means of these different groups do not reveal to what extent the coaching does help the students.

Orissa study also does not reveal any significant difference in mathematics between the students who are helped outside the school hours to learn mathematics by their parents or from teachers (private tuition) and the students who do not get any such extra help.

12.4 Student Variables—Attitudes, etc.

12.41 *Attitude towards Mathematics as a Process*: Toelicit information regarding the students attitude towards mathematics as a process the following question was asked.

(Q.33) Studies in Mathematics are necessary for developments in

(a) Physics and Chemistry

TABLE 12.15

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.78	7.6	152	75%	23.70	7.3	24	13%
	II	23.15	7.5	139		22.72	8.2	29	
Central Schools	I	20.83	9.3	254	81%	11.00	1.4	2	1%
	II	23.11	10.2	224		14.25	3.9	4	
Gujarat	I	25.20	10.7	281	82%	24.90	8.6	11	10%
	II	24.12	9.5	269		22.64	6.5	14	

(b) Economics and Geography

TABLE 12.16

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.16	7.4	106	50%	23.64	7.5	59	32%
	II	21.65	6.3	94		24.75	9.2	66	
Central Schools	I	21.74	10.7	97	30%	19.89	7.9	95	31%
	II	24.11	12.5	90		21.44	7.3	94	
Gujarat	I	24.59	10.6	146	38%	26.82	11.4	68	31%
	II	23.52	9.4	154		24.33	8.9	54	

(c) Education

TABLE 12.17

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.04	7.5	164	81%	22.40	7.1	10	5%
	II	23.00	7.6	157		25.11	12.2	9	
Central Schools	I	21.18	10.1	171	53%	19.31	6.9	38	11%
	II	23.91	11.2	159		20.10	7.2	30	
Gujarat	I	25.40	10.7	233	70%	26.10	11.1	29	11%
	II	24.01	9.2	219		23.5	10.4	33	

(d) Biology, Medicine

TABLE 12.18

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.04	6.9	101	49%	21.84	8.4	63	34%
	II	22.72	7.1	91		23.30	7.3	70	
Central Schools	I	22.1	10.9	80	23%	19.78	7.6	104	35%
	II	24.82	13.7	64		22.00	7.6	111	
Gujarat	I	24.40	10.9	134	44%	26.15	11.0	77	34%
	II	23.35	9.9	117		23.39	7.9	79	

(e) **Engineering**

TABLE 12.19

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.02	7.5	183	89%	19.25	4.5	8	4%
	II	23.24	7.4	170		19.42	9.7	7	
Central Schools	I	20.98	9.3	256	82%	19.66	6.7	3	1%
	II	23.00	10.1	248		19.60	7.1	9	
Gujarat	I	25.14	10.6	290	91%	21.88	7.1	9	5%
	II	23.97	9.4	285		10.18	5.3	11	

Most of the students feel that studies in mathematics are necessary for the developments in Physics and Chemistry and Geography, Biology and Medicine even though the majority feel the necessity for studies in mathematics their number is not appreciably different from their counter parts.

It was hypothesised that those students who feel the necessary of mathematics for developments of these various fields would score better than their counterparts. The results do not show any consistent trend among the groups considered. Only in the case of Central Schools for all these fields definite trend could be seen in the expected direction.

(Q.20) Do you want to study more Mathematics than is usually taught in your school course?

TABLE 12.20

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*Sample*	*m*	*s.d.*	*n*	*Sample*
Haryan	I	22.36	7.5	142	66%	20.57	7.9	55	32%
	II	23.89	7.0	119		21.84	7.9	72	
Central Schools	I	22.07	9.3	173	60%	17.57	8.1	110	33%
	II	24.28	10.1	199		18.44	8.0	94	
Gujarat	I	25.54	10.5	280	83%	21.98	8.1	53	15%
	II	24.31	9.4	277		20.14	6.9	47	

A majority of the students in all the three groups of schools, 66% from Haryana, 60% in Central Schools and 83% from Gujarat wanted more mathematics in their course. The performance of students who expressed this desire is considerably better than that of those stúdents who showed its absence.

12.42 *Attitude towards the Place of Mathematics in Society:* There are three questions in the questionnaire to know the attitude of student regarding place of mathematics in the society and its usefulness.

(Q.22) Studies in mathematics will help you in your future occupation.

TABLE 12.21

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.11	7.7	171	86%	20.24	6.9	25	12%
	II	23.41	7.5	168		21.31	7.5	22	
Central Schools	I	21.03	9.2	256	85%	17.29	8.3	27	8%
	II	22.85	9.8	268		19.08	8.5	25	
Gujarat	I	25.07	10.4	319	94%	24.26	8.2	15	4%
	II	24.06	9.1	306		17.73	9.3	15	

(Q.28) For many occupations in the present day society, studies in mathematics are necessary.

TABLE 12.22

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*Sample*
Haryana	I	22.06	7.5	192	96%	17.40	4.4	5	2%
	II	23.14	7.4	188		21.75	10.6	4	
Central Schools	I	21.16	9.2	248	82%	17.81	5.5	17	7%
	II	22.84	9.9	256		19.03	8.2	27	
Gujarat	I	25.23	10.4	317	93%	20.28	8.2	14	5%
	II	23.89	9.1	304		22.04	10.9	21	

(Q.31) Mathematics is a subject which has no use in life.

TABLE 12.23

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.89	6.8	95	52%	21.92	8.2	101	46%
	II	23.46	7.1	110		22.76	7.9	81	
Central Schools	I	19.88	7.0	25	11%	20.82	9.3	258	82%
	II	18.32	7.1	40		23.17	10.1	488	
Gujarat	I	20.57	8.6	45	23%	25.67	10.5	289	86%
	II	19.28	7.2	45		24.46	9.2	283	

Most of the students expressed that studies will help them in their future occupation and feel the necessity of mathematics in the present day society. The performance of students who saw this relation was also better than their counterparts—consistently in all the groups.

Most of the students in Central Schools (82%) and Gujarat (86%) disagreed with the statement that 'Mathematics is a subject which has no use in life' and their performance was definitely better than their counterparts who agreed with the statement. Suprisingly enough the majority of the students in Haryana State (54%) agreed with the statement.

12.43 *School Learning*—To elicit information regarding students attitudes towards school learning, difficulties in learning mathematics and attitude towards mathematics teachers five questions were included in the questionnaire.

(Q.23) School education is really a waste of time.

TABLE 12.24

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	19.53	5.7	13	7%	21.98	7.7	186	92%
	II	20.06	6.2	15		23,53	7.3	176	
Central Schools	I	19.36	5.0	19	6%	20.81	9.3	264	87%
	II	23.68	8.3	19		22.42	9.9	270	
Gujarat	I	19.88	7.7	18	4%	25.19	10.4	316	94%
	II	22.18	5.8	11		23.74	9.3	315	

(Q.26) Only a few persons can learn mathematics.

TABLE 12.25

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.17	7.4	130	65%	23.46	7.5	65	32%
	II	22.51	6.7	126		24'61	8.4	62	
Central Schools	I	19.74	9.9	112	39%	21.32	8.5	172	55%
	II	21.82	10.1	128		22.98	9.5	167	
Gujarat	I	23.83	9.5	106	31%	25.45	10.8	224	67%
	II	21.85	9.4	99		24.52	8.9	222	

(Q.29) One can get higher marks in Maths, if he crams the formulae.

TABLE 12.26

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.17	6.8	96	50%	21.44	8.4	102	49%
	II	22.19	6.1	103		24.14	8.7	90	
Central Schools	I	18.20	7.6	134	44%	22.87	10.2	150	49%
	II	20.30	7.7	138		24.67	10.9	152	
Gujarat	I	25.29	10.7	101	28%	24.81	10.3	232	71%
	II	23.02	8.2	84		24.02	9.4	239	

(Q.30) Mathematics is a very dry subject

TABLE 12.27

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	19.21	7.1	57	28%	23.10	7.5	138	63%
	II	20.23	6.9	55		24.27	7.4	136	
Central Schools	I	17.64	6.4	78	27%	21.82	9.7	205	65%
	II	18.51	6.2	89		24.24	10.7	194	
Gujarat	I	21.25	9.8	35	9%	25.47	10.4	299	89%
	II	18.39	8.1	28		24.23	9.1	293	

(Q.24) Mathematics teachers are usually harsh and unkind people.

TABLE 12.28

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d*	*n*	*sample*
Haryana	I	19.84	7.7	53	26%	22.54	7.5	146	72%
	II	22.57	8.2	49		23.27	7.2	140	
Central Schools	I	19.62	6.5	66	23%	21.04	9.8	217	70%
	II	20.42	7.2	75		23.13	10.5	217	
Gujarat	I	24.77	9.6	35	11%	25.01	10.4	299	88%
	II	24.16	7.8	37		23.60	9.3	288	

Most of the students disagree with the statement that 'school education is really a waste of time' and their performance is better than their counterparts (less than 10%) in all the three groups of schools except in Central Schools.

A majority of the students, 55% in Central Schools and 67% in Gujarat disagree with the statement that only a few persons can learn mathematics. But it may be noted that the students who agree with the statement are in considerably large minority *viz.*, 39% in Central Schools and 31% in Gujarat. In Haryana a majority of the students, 65% agree with the statement as compared to 32% who disagree with it. In all the three groups of schools those students who do not agree that only few persons can learn mathematics performed better than their counterparts.

It seems many students at least in Haryana and Central Schools feel that they can get higher marks in mathematics if they cram the formulae. Only in Gujarat lesser number of students share this attitude. The performance of those who do not believe in cramming is better than those who believe in cramming in all the cases—except in one test form in Gujarat.

A considerably large number of students, 28% in Haryana and 27% in Central Schools expressed that mathematics is a very dry subject, while only a small minority, about 9% in Gujarat shared this opinion. As expected the students who do not feel that mathematics is a dry subject and who are in majority in all the three groups performed far better than their counterparts in mathematics achievement. The results reveal large differences in the means in all the three groups of schools.

A large number of students 26% in Haryana and 23% in Central Schools think that the mathematics teachers are usually harsh and unkind people and a lesser number of students, 11% in Gujarat think the same. The majority of the student however expressed their opinion against the statement. As expected, the performance of the majority who expressed a favourable opinion towards mathematics teachers was better than their counterpart in all the tests—except in one form in Gujarat State.

In the Orissa Study it was found that those who have developed special liking for mathematics will have a better performance than those who have not. In the IEA study of the relationship of Mathematics Achievement with Interests and Attitudes of students, the following hypotheses were formulated: Total mathematics scores will be related to students' interest in and attitude towards mathematics. In particular, students with higher achievement scores will: (i) have greater interest in mathematics, (ii) have greater interest in taking more mathematics; (iii) view mathematics as an open system; (iv) view mathematics as a subject most students can learn; (v) view mathematics as an increasingly central subject for occupations and for the development of society. In general these hypotheses were supported by the findings.

12.44. *Attitude towards Man and his Environment*—Three questions were there to elicit information regarding attitude towards man and his environment.

(Q. 25) Human beings are controlled by fate.

TABLE 12.29

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.51	6.9	130	64%	22.73	8.5	68	34%
	II	23.11	7.5	122		23.52	7.1	67	
Central Schools	I	18.59	7.3	102	36%	21.92	10.1	164	52%
	II	21.39	8.3	123		23.68	10.9	156	
Gujarat	I	23.57	10.6	136	37%	25.94	10.2	196	60%
	II	22.58	8.6	112		24.34	9.6	205	

(Q. 27) Science is leading mankind to destruction.

TABLE 12.30

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	21.11	6.7	71	33%	22.61	7.9	122	64%
	II	22.89	7.1	59		23.38	7.7	129	
Central Schools	I	20.56	7.7	81	29%	20.79	9.7	194	60%
	II	22.57	6.7	99		22.80	11.3	117	
Gujarat	I	24.74	10.2	117	34%	25.09	10.6	209	62%
	II	23.53	9.2	110		24.02	9.2	204	

(Q. 32) Man can control nature (environment) by scientific discoveries.

TABLE 12.31

Group	*Test Form*	*Yes*				*No*			
		m	*s.d.*	*n*	*sample*	*m*	*s.d.*	*n*	*sample*
Haryana	I	22.37	7.4	154	78%	20.38	7.5	44	21%
	II	22.98	7.4	154		23.75	7.8	37	
Central Schools	I	21.23	9.5	203	63%	19.46	8.1	77	29%
	II	22.70	10.6	180		22.17	9.4	100	
Gujarat	I	24.52	10.5	238	70%	26.35	10.1	88	27%
	II	23.73	9.2	230		23.91	9.4	91	

Majority of the students in Central Schools and Gujarat had less faith in fate. Still there are considerable number of students—36% in

Central Schools and 37% in Gujarat—who still believe that the human beings are controlled by Fate and this was shared by the majority of the students, about (64% in Haryana. However in all the three groups the group which disagreed with the statement that human beings are controlled by fate performed better than their counterparts.

Results reveal that the majority of the students in all the three groups of schools realised the importance of science and disagreed with the statement that Science leading mankind to destruction. However about 33% in Haryana, 29% in Central Schools ad 34% in Gujarat had feared that Science is leading mankind to destruction. As expected students who disagreed with the statement that Science is leading mankind to destruction, who are larger in numbers, performed better than their counterparts.

Majority of the students in all the three groups of schools agreed that through the scientific discoveries Man can control nature (environment). However no definite statement can be made as regards their performance. One can see that Q. 25 and Q. 32 are somewhat related as regards scientific values. It may seem somewhat surprising—although it is usual paradox—that while a majority of the students in Haryana expressed that the human beings are controlled by fate, in the same state a majority of students assert that Man can control nature (environment) by scientific discoveries. A possible explanation for this anomaly is that Haryana is mostly an agricultural state and less industrialised as compared to Gujarat. Students here in general even when they realise the value of science still believe in Fate.

12.5 Conclusions

What do all these low positive and zero correlations, significant and non-significant differences indicate to an educational planner or a teacher?

Must he throw his hands up saying that because the feeder community is poor or the parents are not educated the educational achievement will always be poor? Or that just have more industrilization and higher salaries and thereby raise the educational achievement? No such simple formulae could be deduced from the data. It seems the most powerful variables are those which operate within the school like teaching methods, curriculum etc. and those which are related to the student's attitudes. The remoter variables like socio-economic conditions of the parents or school type e.g. government or private operate only to the extent they deliberately improve the teaching-learning situations and help a student to build a positive attitude towards study. This gives the educational planner and also the teachers, a hope that they can contribute much more towards raising the standards of education than feeling completely frustrated by the prevailing politico-economic circumstances.

CHAPTER 13

DATA PROCESSING

13.1 Introduction

With the introduction of electronic computers in the field of research, it is fairly known that the computers are very useful for processing speedily large bulk of data especially involving complex calculations. MAS project involved large samples and most of the data processing was done on computers. In this chapter a brief description is given regarding data processing procedures adopted for the MAS project

13.2 Test Format

Keeping in view the data processing requirements, uniform format was adopted for printing the tests in different regional languages. The arrangements of items and distractors were identical in all the language versions of the tests. Further arrangement of questions—which elicit information regarding the student variables was also identical in all the language versions. This uniformity in the format facilitated speedy and accurate coding and punching of the test booklets in different languages—even though the coders and punch operators were not familiar with many of the regional languages.

13.3 Data Processing—Try-out Stage

All the test booklets received from various parts of the country were first scrutinised and sorted according to the state, language, level and the test form. Necessary coding—which includes identification coding and coding of information on student variables on the front page—was done by the project staff itself at the centre. These test booklets were then sent for punching. Eighty column punch cards were used for punching. One card per student at the Primary level and two cards per student at Middle and High School levels were used for punching the student's responses and information on other student related variables. These punched cards after verification were sent for processing on electronic computer.

The main objective of the try-out of MAS tests was item analysis. Processing of the data included scoring of student responses and computing frequency distribution of scores, means and standard deviations. Further proportions of students in the upper 27% and lower 27% groups, as well as for the total group responding to each of the choices of the items in the test, were computed. These results were obtained with the help of computers for each of the four test forms at the three levels for all the states which participated in the try-out. These results were then tabulated by the project staff for the purpose of item selection.

13.4 Data Processing—Final Stage

The final survey was conducted with the twin objectives in mind viz. to assess students' achievement in mathematics and then to study its relation with some school variables, student variables and other related variables of interest. As such a much larger number of schools were selected in the sample as compared to the tryout stage. This larger number of schools which in turn meant larger number of students posed some problems at various stages of the data processing. A moderate estimate of punching time required came to roughly six months—expecting round about 70% of the turn-out. With the limitations on available funds for data processing and tight time schedule of the project, it was decided to resort to sub-sampling of test booklets received from the schools and do further processing. However in a few states analysis was carried out on the complete data for the purposes of items analysis and attitude study. Details of sub-sampling procedure have already been discussed in the chapter on sampling. These answer scripts were then sent for punching and verification. These punch verified cards were further put to quality control checking by way of selecting cards randomly by the project staff—to see that no values outside the allowable range were punched. By this time a small punching section started functioning within NIE and it took few months to complete the whole punching work.

In many large scale surveys the most time consuming phase of data processing seems to be punching of the cards. To overcome this difficulty in the advanced countries like U.S.A. special type of cards are used as answersheets on which students can mark their responses with the help of lead pencils. These cards can be fed into the computer directly. However such facilities were not available for this project.

13.41 *Data Processing—Primary Level.* One card per student was used for punching information related to student variables and the responses for fifty questions in the primary level tests. First 15 columns were used for identification and columns 16 to 23 were used for punching information relating to students and columns 24 to 73 for responses on the items. The card design at the primary level is given in Appendix 13.1.

13.42 *Data Processing—Middle Level.* Middle level tests contain 70 items and thus 70 columns are required to punch the responses. That leaves 10 columns in a 80 column card. To save punching time and processing time it was decided to use only one card per student. That meant that all the identification and related information had to be squeezed into 10 columns. For this purpose multiple coding was resorted to; some information had still to be sacrificed. First 6 columns were used for identification, columns 7 to 10 for punching information on related variables and columns 11 to 80 for punching student responses to the seventy items in the test. Some of the affected variables were 'management' and 'sector'. As such means and standard deviations could not be obtained on computer for regions within a state. However these details could be worked out for the total group. Card design at the middle level is given in Appendix 13.2.

13.43 *Data Processing—High School Level.* At the high school level seperate answersheets were provided to the students to record their responses on the items of the tests. Further a questionnaire was also administered to the students along with the test proper to elicit additional information on the socio-economic variables related to the students and their attitude towards some important aspects of learning. Separate answersheets provided to the students facilitated increase in punching rate as compared to the rate at which primary and middle level cards were punched.

The high school tests consist of 80 items and two cards were used to punch the necessary information. The card design at the high school level is given in Appendix 13.3. First 15 columns were used for identification code in both the cards for each student. In the first card column 16 to column 75 and in the second card column 16 to column 35 were used for punching responses to the items in the test and column 36 to column 78 in the second card were used to punch information on the questionnaire.

The processing of the high school tests took much computer time as it was done in two phases. The first phase consists of scoring the student responses and getting the frequency distributions, percentiles, means and standard deviations on the variables like sector, management, sex etc. At the same time these scores along with consolidated information on questionnaire were punched out on cards by the computer as output—one card per student. These cards were then fed into the computer again for attitude study.

13.5 Data Bank

One of the advantages in having data of large scale educational surveys on cards is to provide Data Bank facility to later researchers. The "bank" is a record of all the basic information about a student including the scores, in a compact form so that relevant information can be retrieved back at any time.

This is of help to individual researchers as well as research organisations to study any particular aspect of interest or to conduct follow-up studies. For example in the IEA Survey in Mathematics all the relevant information regarding the student and school variables were put on magnetic tape in a compact form. Magnetic tape being an efficient medium of storing any information can be retrieved within a short time.

In MAS project most of the processing was done as one-way analysis. It will be of interest to later researchers to do more comprehensive analysis. To help the research workers in this direction all the punched cards relating to MAS project were stored—this can be considered as the Data Bank of this project. Card designs at the Primary, Middle and High school levels given in Appendix 13.1, 13.2 and 13.3 respectively will give a complete picture of the information available in the MAS project Data Bank. It is hoped that studies involving various psychometric problems, as well as those involving socio-cultural hypotheses, will be conducted later utilising the facility of Data Bank.

APPENDIXES

APPENDIX 1.1

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APPENDIX 3.1

COMMON & LESS COMMON TOPICS
PRIMARY STAGE

1. Numeration and Notation of Numbers. Place value of digits.
2. Addition
3. Counting by 2's, 5's and 10's
4. Subtraction
5. Idea of +, —, =, ×, — signs and use.
6. Multiplication
7. Recognition of coins, their relationship and use
8. Division
9. Units—Weights, Lengths, Days of week, Day, Hour, Minute, second/capacity.
10. Fractions—Use of brackets and decimals
11. Prime and composite numbers, factors and products, LCM and HCF
12. Simple business *gurs*—bills and receipts—accounts
13. Family budget and accounts/taxes etc.
14. Unitary method
15. Simple interest
16. Recognition of triangle, square, angle and straight and curved lines, quadrilateral, circle. Drawing straight, curved lines, right angle, triangle. Properties of parallel lines and triangles.
17. Recognition of cylindrical and spherical solids.
18. Drawing and understanding the properties of square, rectangle & circle.

Less Common Topics

Roman Numbers
Decimals
Shorter Methods in Multiplication and Division
Simple and Compound Interest
Percentage, Profit and Loss
Averages
Area
Ratio and graphs

Middle School

Arithmetic

1. Four fundamental rules. Compound rules. Units of measurement. Emphasis on metric units
2. Fractions
3. Decimals
4. HCF and LCM
5. Unitary method
6. Practice
7. Average
8. Percentage
9. Profit and loss
10. Square root
11. Simple Interest
12. Compound Interest
13. Ratio and proportion. Proportional division.
14. Time, distance and speed
15. Work and Wages
16. Area and Volumes
17. Graphs
18. Bills and receipts/simple accounts/Mahajani *gurs*/Bahikhata.
19. Partnership

Algebra

1. Introduction—generalized arithmetic—algebraic symbols/substitution.
2. Four simple rules
3. Insertion and removal of brackets
4. Simple equations/problems
5. Simultaneous equations with two unknowns/simple problems
6. Simple graphs
7. Formula & their application: Square of sums and difference of two terms
   Difference of two squares
   Square of sum of three terms

Geometry

1. Idea of a solid surface
2. Straight line—measurement, perpendicular to a line, parallel lines, bisection, dividing into number of parts or in given ratio.
3. Angles—measurement, kinds of angles, vertically opp. angles, bisection, construction of different angles like 90°, 60°, 45°, etc.

4. Triangle—kinds, construction, angles,—their sum, property, Congruent triangles, area.
5. Quadrilateral—Construction (Squares, Rectangles, Rhombus) Parallelogram equal in area to a traingle, parallelogram, quadrilateral.
6. Circle—Centre, Arc, Radius, Construction. Relation of diameter to circumference/area.
7. Experimental Verification—Theorems of angles at a point, triangles, parallelograms, circle, perpendicular through mid-point of the chord.

Less Common Topics

Proofs of Theorems on angles at a point,
Parallel lines, triangles—congruency,
relation between sides & angles

Parallelogram/Area of a Rectangular Parallelogram,
Triangle, Pythagorus' theorem.

Arithmetic (High School)

1. Numeration.
2. Four Fundamental Operations
3. Factors and Prime Numbers
4. HCF and LCM
5. Fractions (Vulgar & Decimal)
6. Square Root
7. Average
8. Percentage
9. Profit and Loss
10. Simple Interest
11. Compound Interest
12. Ratio and Proportion
13. Unitary Method
14. Present Worth & Discount (Banker's Discount)
15. Time & Work and Time & Distance
16. Stocks and shares
17. Areas and Volumes
18. Circle—circumference and area

Less Common Topics

Exchange
Partnership

High School Stage

Algebra (For Lower Maths.)

1. Four Fundamental Operations.
2. Algebraic Formulae and Factors:—Quadratic expressions, sum or difference of two squares and cubes
3. H.C.F. and L.C.M.
4. Fractions
5. Simple equations with problems
6. Simultaneous equations with problems
7. Graphs—equations of first degree, simple statistical graphs.
8. Quadratic equations by factorisation only

Less Common Topics

Square Root
Ratio and Proportion

High School Stage

Algebra (for Higher Maths)

1. Theory of Indices—Fractional and Negative Values
2. Algebraic Formulae—Application to Trinomials
3. Harder Factorisation—Remainder Theorem
4. H.C.F. and L.C.M.—upto 2nd degree
5. Harder Fractions—Partial Fractions
6. Simple and Simultaneous Equations with Problems
7. Ratio and Proportion
8. Identities and Elimination
9. Surds—Rationalization of surds
10. Graphs—of statistics, Ist and 2nd degree
11. Quadratic Equations, Theory of Quadratic Equations, Theory of Quadratic Functions
12. Rational and Irrational Numbers—Real and Imaginary Quantities
13. A.P., G.P. and H.P.
14. Permutations and Combinations
15. Binomial theorem for positive integral index—application for negative and fractional indices

Less Common Topics

Variations
Logarithms

High School Stage

Geometry

Theoretical

1. Theorems on Angles at a Point
2. Theorems on Parallel Sraight Lines
3. Theorems on Triangles and Rectilinear Figures
4. Theorems on Areas
5. Theorems on Loci
6. Theorems on Circle
7. Theorems on Proportion: Similar Triangles, Exercises based on the above Theorems

Practical:

1. Bisection of angles and of straight lines
2. Construction of perpendicular to straight lines
3. Construction of an angle equal to a given angle.
4. Construction of parallels to a given straight line.
5. Construction of Triangles, Quadrilaterals, square, Rectangle, Parallelogram, Rhombus, Trapezium; Evaluation of their areas. Reduction of a quadrilateral of polygon into an equivalent triangle.
6. Division of a straight line into a given number of equal parts or into parts in any given proportion.
7. Construction of a Triangle equal in area to a given Polygon, Rectangle to a given Polygon, Rectangle on a given base equal in area to a given Rectangle, Rectangle of a given area—sum and difference of sides.
8. Construction of Tangents to a Circle and of Common Tangents to two circles.
9. Simple cases of construction of circles.
10. Construction of a fourth proportional to three given straight lines and a mean proportional to two given straight lines.
11. Construction of regular figures of 3,4,6 or 8 sides in or about a given circle.
12. Construction of a square equal in area to a given polygon.
13. Construction of a circle about or in a given triangle.

Less Common Topics

1. Division of a given straight line in extreme and mean ratio.
2. Construction on a given line of a figure similar to a given rectilinear figure.
3. To find a point in a given straight line such that the sum of the distance of two given points from it is a minimum.
4. Two sides of a Triangle being given to construct a triangle such that its area is maximum.
5. Determination of areas of Irregular Rectilinear figures by (i) Triangulation (ii) Field Book method, using one basic line.

APPENDIX 3.2

ANALYSIS OF TOPICS

Decimals (*Middle level*)

1. **Multiplication**

Note: (a) and (b) covered at Primary Stage but a revision will be made at middle stage.

(a) Multiplication of decimal fraction by 10, 100 and 1000.

(b) Multiplication of a decimal fraction by a whole number:
  (1) Tenths by tens and hundreds.
  (2) Hundredths by hundreds and tens.
  (3) Tenths by whole numbers.
  (4) Hundredths by whole numbers.

(c) Multiplication of a decimal fraction by a decimal fraction:
  (1) Tenths and Tenths.
  (2) Tenths and Hundredths.
  (3) Hundredths and Hundredths.

2. **Division**

Note: (a) and (b) are covered at the Primary Stage but a revision will be made at Middle Stage.

(a) Division of a decimal fraction by a whole number:
  (1) Tenths by whole numbers other than ten.
  (2) Hundredths by whole numbers.

(b) Division of decimal fraction by decimal fraction:
  (1) Tenths by Tenths.
  (2) Hundredths by Hundredths.
  (3) Hundredths by tenths.
  (4) Mixed

(c) Approximate values—upto given number of decimal places.

3. **Change of decimal fractions into vulgar fractions**

(a) Pure decimal fraction

(b) Zeroes immediately after the decimal point
(c) Mixed number
(d) Recurring decimals into fractions

4. **Change of vulgar fractions into decimal fractions**

(a) When the denominator of the fraction is a factor of 10 or multiple of ten
(b) When it is not a factor of ten or multiple of 10
(c) When the fraction is *improper* or *mixed*
(d) Fractions into recurring decimals

5. **Comparison: Place value of digits**

(a) of a decimal fraction and decimal fraction
(b) of a decimal and vulgar fraction

6. **Problems involving multiplication, division and other processes**

Concepts:

(1) Concept of approximate value
(2) The decimal point does not change but the digit changes place in multiplication & division processes

Rules:

(1) When a decimal fraction is multiplied by another the product is always less.

Situations:

Common problems of daily transactions involving metric units of measurement.

Common mistakes:

(1) Placing of the decimal point while multiplying a decimal fraction.
(2) Placing of the decimal point while dividing a decimal fraction by a decimal fraction.
(3) Overlooking the investing of zeros in the divident whole finding the approximate value, upto given number of decimal place.
(4) Place value of the digits after and before the decimal point particularly when there are zeroes after the decimal point.

APPENDIX 4.1

SOME SPECIMEN ITEMS IN THE PRE-TRY-OUT TEST
(FORM 1 — MIDDLE LEVEL)

Item No. *Answers*

1. A person deposited Rs. 5000 in the bank at 4% Compound Interest per annum.
   (a) What interest will he get if he withdraws the amount after one year? (a) ______________
   (b) What total amount will he get if he withdraws it after two years instead of one year? (b) ______________

---

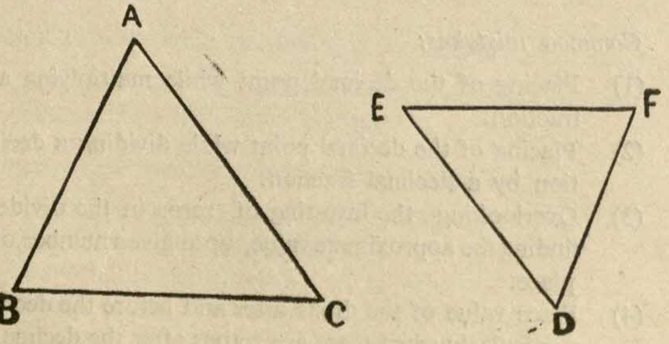
2. If $a=5$, $b=3$, $c=1$, find the value of:—
   (i) $a(b+c)^2$ (i) ______________
   (ii) $c(a+b)^3$ (ii) ______________

---

3. Divide:—
   $24x^2-65xy+21y^2$ by $8x-3y$ ______________
   ____

---

4. Traingles ABC, DEF are similar with $\angle A=\angle D$; $\angle B=\angle F$. *Answers*



Then

(i) $\frac{AC}{DE} = \frac{BC}{?}$ (i) ______________

(ii) $\frac{AB}{DE} = \frac{?}{EF}$ (ii) ______________

APPENDIX 4.2

SUGGESTIONS FOR WRITING MULTIPLE CHOICE TEST ITEMS

1. Plan the writing of initial item drafts so that subsequent revision and assembly into the finished test will be as easy as possible.

   A. Write the initial draft of each item in pencil on a separate sheet of paper.
   B. Write the item first, then the answer, then the distractors. (Always make the first response the best answer in the initial draft.)
   C. Use an outline code on each initial draft sheet to show where the item on that sheet fits in the test outline.
   D. Do not number the items or the responses on the initial draft. Space items and responses to allow for revision or substitution.
   E. Arrange for a competent colleague to review and suggest improvements in the original drafts of the items. The item writer should review and revise the items himself after they have grown "cold " (some days after they were written initially.)
   F. Assemble the items in topical groups, or in estimated order of increasing difficulty and number the items.

2. Seek ideas for test items which will require the examinee to show attainment of important instructional objectives, instead of items which only require recall of details of course content.

   A. Obtain ideas for achievement test items by studying textbooks, course syllabi, and other instructional materials.
   B. Base items on important general ideas, instead of on unimportant details.
   C. Base items on useful, instead of on ornamental, knowledge.
   D. Base items on ideas whose meaning and truth is not dependent on the context in which they were presented in the instructional materials.
   E. Choose ideas whose truth can be defended on better grounds than the opinions of a particular writer.
   F. Choose ideas whose truth is not self-evident, or a matter of common knowledge regardless of special training.

G. Choose ideas which will help to discriminate between examinees of high achievement, and those of low achievement, in the area covered by the test.
H. Write items which will require ability to explain an idea, or to apply it in a specific, novel situation, as well as items which only require knowledge of the idea.
I. Write some items which require knowledge of important facts, or understanding of important terms, as well as items based on important general ideas.
J. Avoid items which hold the examinee responsible for esoteric terminology, or for some arbitrary organization of subject mattter.

3. Begin the item with a stem question to which a reasonably adequate answer can be given concisely, and for which plausible wrong answers can be found.

A. Be sure a specific question is asked or implied in the item. The stem should orient the examinee to the problem involved in the item.
B. Prefer a direct question to an incomplete declaration as the stem of a multiple choice test item.
C. Do not reduce the significance of the stem question by qualifying it so completely that an absolutely and entirely eorrect answer can be given to it. The best answer to a multiple choice test question need not be, and often cannot be, a thoroughly correct answer.
D. Write more questions which require descriptive statements, or statements of ideas, as responses, than questions whose stems have been adapted to permit one-word lable type responses.
E. Reward the critical minded examinee, and penalize the lesson-learner, by inventing novel questions and problem situations. Avoid using the same questions and problems as those used in instruction.
F. Use stem questions which ask as directly and simply as possible for the essential knowledge or ability which the item is intended to measure.
G. In general avoid negative statements, but if the word *not* does appear in the stem or question, underline it to draw the students attention to it.
H. Prefer bonafide questions, which would be asked by some one honestly seeking knowledge, to quiz type questions, which would only be asked by someone who already knows the answer.
I. Do not address the examinee personally, as if asking for his opinion instead of testing his knowledge or ability.

4. Word the item as clearly and simply as possible.

   A. Express the item as concisely as possible, avoiding unnecessary words and non-functional materials (such as "window dressing", or instructional) which do not help to make the question clear or the best answer defensible.
   B. If many descriptive or qualifying ideas are necessary to set up the question, place them in a separte introductory sentence in the item stem.
   C. Avoid ambiguity resulting from vague, figurative or colorful wording, or from complex sentence structure.
   D. Reward understanding and penalize rote learning by avoiding verbal stereotypes in the item stem or correct response, but using them freely in the distractors.
   E. Word and punctuate the item so that it is grammatically correct and effective in expressing the intended idea.
   F. Avoid any unintentional inaccuracy in wording the item stem or correct response, because these may mislead the more careful and perceptive students.

5. Choose, express and arrange the responses so that they contribute to the clarity of the item.

   A. Be sure all the responses are appropriate to the item stem, and parallel in structure and point of view.
   B. Make each response distinctly different in the thing it refers to, or the idea it expresses.
   C. Eliminate from the responses any words or phrases which are needlessly repeated in all responses.
   D. Eliminate from the responses any elements which tend more to complicate and obscure than to clarify the essential differences between them.
   E. Put the responses after the stem rather than in it or before it.
   F. Put the responses in a list rather than in *tandem.*
   G. If there is any natural order or sequence among the responses, follow it in listing them e.g., while dealing with items that have numerical answers, arrange the answers in order from large to small or vice versa.

6. Include one best response as the answer to the stem question.

   A.. The question asked should admit a best answer.
   B. All conditions and limitations necessary to determine the best answer should be specified.
   C. The best response should be one on which qualified judges can agree.

D. The best response should be an adequate answer, but need not be a perfectly correct answer, or the only possible acceptable answer.

E. The bestness of the answer may be a matter of expert judgment or opinion as well as a matter of fact.

F. The best answer should not only be better than any of the other responses, but should be reasonably adequate in the eyes of qualified judges.

G. Use *None of these* or *all of these* as responses to correct answer items, never to best answer items. Preferably do not use "all of these" as a response.

7. Avoid clues which permit a poorly prepared but clever examinee to respond correctly.

A. Do not give away the correct answer by including in it alone some key words or phrases which appear in the stem, or the synonyms or usual concomitants of those key words or phrases.

B. Make all responses equally consistent with the stem grammatically and semantically.

C. Avoid distractors which are more like each other than they are like the correct answer.

D. Do not consistently express the correct response more carefully and at greater length than the other responses.

E. Avoid items in which the correct response can be selected on the basis of common sense logic.

F. Avoid using a familiar verbal stereotype as the best answer to a question.

G. Guard against the possibility that the wording of one item may inadvertantly supply the answer to another.

8. Make each incorrect response (distractor) plausible enough to appeal to a substantial number of poorly prepared examinees.

A. Make the distractors superficially attractive by including familiar stereotypes, misconceptions and verbal or logical false clues.

B. Sometimes use true statements which do not constitute good answers to the stem question as distractors.

C. Do not use in a distractor any term or idea which is less familiar than the correct response. Avoid highly technical terms and abstruse ideas in the distractors.

D. One way of getting distractors is to study the errors students commit, sometimes these errors are due to complete ignorance; and not many students would commit the same errors. But there are errors that are due to partial knowledge or misconception in a given area. These are the types of errors which should be used as distractors.

9. Try to write four responses to each item. (In the initial draft write five distractors).

   A. Try to use responses which represent stops or intervals on a quantitative or qualitative scale covering all reasonable possibilities.
   B. Sometimes combine two elements of two alternatives each to provide four responses.
   C. Sometimes combine the question "Is it true?" with the question "Why?" or "Explain" to provide four responses. The responses in such a case would state conditions under which a statement given in the stem would be true or not true.
   D. Allow the number of responses per item to vary if more than four good responses are available, or if reasonable effort fails to produce four good responses.

10. Write questions so that approximately one half of the examinees will be likely to answer each question incorrectly. (In a survey test this rule need not be applied very strictly.)

   A. Limit questions to those on which substantial misinformation or common misconceptions are known to exist.
   B. Make the stem question easier, when necessary, by making it more general, or more difficult by making it more specific.
   C. Make the correct response easeir to select, when necessary, by making it less like the distractors, or more difficult by making it more like them.
   D. Make an item easier, when necessary, by providing more than one basis for a correct response.

11. Make each item completely independent of every other item. Suppose that in arithmetic we have two successive items, the first of which requires the correct solution for the area of a certain type of figure. The second item asks the student to compute the cost of laying a certain type of floor covering over the first area at so much per square feet. If the answer to the first item is incorrect then it becomes impossible to solve the second correctly. A student knows how to compute correctly the cost of the floor covering, but, perhaps, because of a simple arithmetic mistake in the first item, he gets no credit on the second. Such groupings of items lower the validity of a test.

APPENDIX 4.2a

SOME ILLUSTRATIVE ITEMS CIRCULATED TO ITEM WRITERS

Item No.

1 Kapoors who live in Delhi planned a trip to Bangalore. They discussed whether to go by car or aeroplane.

Mr. Kapoor said that if they went by car they would average 350 miles per day. This means that:

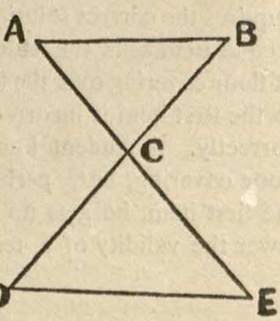
(A) They would drive exactly 350 miles each day.
(B) they would never drive less than 350 miles in one day.
(C) they would never drive more than 350 miles in one day.
(D) if they drove less than 350 miles on some days they would drive more than 350 miles on other days.

2 Ram is *n* years old. His father is 8 times as old as his son. How old will the father be after ten years?

(A) $n+8 \times 10$
(B) $n \times 8 \times 10$
(C) $8n+10$
(D) $10n+8$
(E) $(n+10)\ 8$

3 In the figure if $\angle E < \angle A$, which one of the following conclusions can be drawn:

(A) AB is *not* parallel to DE
(B) AE is *not* perpendicular to DB
(C) $\angle D < \angle B$
(D) $\triangle ABC$ is not similar to $\triangle DEC$
(E) None of the above.



APPENDIX 5.1

NOTE TO THE TRANSLATORS

Purpose

The purpose of translating the English drafts of the mathematics tests in regional languages is to prepare tests which are identical in mathematical content but could be understood by students all over India. It must be emphasised that the tests in spite of the translations in regional languages must remain equivalent tests. The equivalence is to be considered not only statistically or in mathematical content, but also in terms of psychological reactions. In order to achieve this, some of the following hints may be borne in mind while translating these tests.

1. Please read the whole test before starting to translate it.

2. **Literal translation not necessary** : The translation need not be a literal translation. One may change the complete sentence format in English to an interrogatory sentence format to suit the diction of the regional language. One may even have to use more than one word for a word in the English draft or vice versa. The various nuances—differences in, or shades of meanings in English—are to be brought in the regional languages with adequate force. This might require patient reading of the items in the English draft and careful translation in the regional languages.

3. **Situation may differ but mathematical content and operations are to remain identical**: Although the translation is not to be literal, the mathematical content and operations involved in the item must remain identical. This is easier to do when the item does not involve any real life situation. But whenever the real life situation is involved which is the case in many application type items, the translation might become difficult. The translator must consider first whether the situation is familiar to students in the given state. The situation might be referring to games, fruits, certain business transactions, etc., etc. The students should be conversant with the situation even if they do not know how to solve the mathematical problem involved in the item. We have tried to use situations that are familiar to students all over India. But in a particular region a given situation may be quite unfamiliar. In such a case the situation is to be changed to suit the regional culture. But the change should be done in such a manner that it does not affect in any way the mathematical content or operations involved in the item. But changes in situations should not be made unless absolutely essential to make the item understandable to the children in a given region.

4. **Translate the item involving changed situation into English**: All such items where changes in situation have been made in the regional language draft should be translated into English. This will enable the centre to compare these changes from region to region and to keep the mathematical content identical.

5. **Proper nouns may be changed**: The proper nouns—names of persons, places, etc.—may be changed. The only care that may be taken is to use names which are short, e.g. Ram. Some of the common nouns, e.g., names of fruits, etc., may also be changed. But while changing these we should also take care that such changes do not necessitate a change in the content in order to make the situation genuine, e.g. an item might be speaking of bananas which cost a certain amount of money. When we change bananas to some other fruit we have to see that the cost, now referred to in the item, is appropriate for the new fruit used in the translation.

6. **Translation of numerals**: In some states, although the regional language is the medium of instruction, the numerals that are used are not those from the regional language. In some states the English numerals or what are called, the Arabic numerals are used even in a textbook which is otherwise written in a regional language. The state governments might have taken some decision in this regard. While translating the test, care should be taken to follow whatever decision the State Government has taken. If no formal decision has been yet arrived at, textbooks that are currently being used in a given state should be looked into and the practice followed in these textbooks should be employed in the test.

7. There are many diagrams in these tests. It is considered desirable that as far as possible the same block should be used in all regional language tests. This would mean that in the diagrams we shall use English letters, R.S.T. etc. It is thought that this may not create difficulties for middle level and high school level students. (At the primary level, however, this procedure might create difficulties in those states where English is introduced only in grade VI. Hence diagrams for the primary level test should be translated in the regional language, i.e. proper letters from the regional language should be used while at the middle and high school level test the diagrams need not be translated, unless it is absolutely necessary because of unfamiliarity of the students with the English letters).

In this draft we have not drawn very accurate figures. In the translated copies also you need not spend time on drawing accurate figures, as accuracy of figures will be taken care of at the time of printing. But if in any figure there are any words used, please translate them wherever necessary.

8. For an English word there might be more than one regional word and all of them may be appropriate. It would be desirable though to use one word throughout the test to refer to the same English concept. To give an illustration, a rectangle is translated in Hindi as *ayat*. It could also be

translated as *lambchaukon*. Once a decision is taken that *ayat* is to be used then the same word should be used throughout the test to represent a rectangle. The same practice is to be adopted for non-technical words also.

9. In spite of the changes suggested above the item format has to remain the same. This will imply the following things:

(a) If there is any figure or diagram after the stem then in the translation also we must keep it after the stem. The words 'below' or 'above' and 'so on' must be carefully noted in this context.

(b) The responses begin with letters A, B, C, D, E, F. It seems to us that for the middle level and high school level they may be the same as in English version. But if you think that the students of middle schools will not understand the letters A, B, C, D, E, F, then change them to some letters in regional language and then use them consistently in all the items against the responses.

(c) In the English draft we have decided *not* to use the abbreviations like 'm' for meters or kg. for kilograms. We have used the full term 'meter' or 'kilogram' respectively. Please do not use abbreviations in the translated version also. Similar is the case with geometrical symbols, e.g. for triangle. These are also to be written in full. In all cases of symbols except the symbol "= , (,) " use the complete term in words.

(b) In the English version certain words are underlined like *false*, *necessarily*, *not*, etc. Please underline the equivalent word in the translation, as well.

10. After the translation is prepared it is to be sent to an evaluator. The translation may be written on the right hand margin in the test itself. If the space is not enough you may use separate sheets. If there are more than one evaluators it might be worthwhile writing the whole translation on a separate sheet of paper and using carbon for more than one copy. These copies then could be sent to the evaluators for their comments. Please send the English version also to the evaluator. The evaluators will give their comments in the forms provided to them. In some cases they may write their comments in English version itself. Cols. 1-6 of the form should be particularly useful for the translator in revising the translation.

11. The translator should revise the translation in the light of the comments made by the evaluator without forgetting the basic objective of the translation, namely, to prepare equivalent tests in spite of differences in regional languages.

12. The revised copy of the translated test should be sent to the Co-ordinator Mr./Mrs./Miss——————————for approval. He will then in turn send the final draft to the Principal Investigator of the Survey. In addition to the final draft of the translation please do not forget to send us the English translation of items where changes in situations have been made by you to suit the regional requirements.

APPENDIX 5.2

NOTE TO THE EVALUATORS OF THE TESTS

The purpose of evaluating these tests is to see that they are intelligible to the children from language point of view and also to check that the test items, after their translation into the regional language, are equivalent to the original English items. With this purpose in mind the evaluator may give his suggestions in the enclosed proforma so as to improve the translation of the test items. (The column numbers refer to columns in the proforma).

Col. 1—In this column the item number is to be written. One may not have suggestions for each item and hence the numbers may not be consecutive. But whenever there are suggestions, please indicate the number of the item first in this column.

Col. 2—Here changes in words are to be noted. The evaluator may feel that the word used in the translation is not appropriate—does not convey the meaning which the original English word tries to convey or it is not intelligible to the students in the State. He might, hence, suggest more appropriate words which can substitute the word used in the translation. All such words are to be noted in this column along with the original word in the translation. It might be noted here that proper nouns—names of persons, places, etc. used in English draft could be changed to suit the regional culture. However, these names should not be lengthy. Similar is the case with names of fruits, etc. Such changes should be made to the extent that they do not affect the mathematical content and operations involved in the test item.

Col. 3—The evaluator may, some time, feel that the word or words used in the translation are appropriate for a certain region in a given state, but are not understood by students in other regions of that state. In such a case synonyms which could be understood in other regions should be suggested. These synonyms would then be written into brackets along with the original word in the translation. In some states it might be advisable to use the English term in brackets, especially at the middle and high school level. This strategy depends on the use of English while teaching mathematics in a given state. The evaluator should give some thought to the practices in schools and suggest the words to be used in brackets.

Col. 4—Here the evaluator might suggest a change in the structure of a sentence(s). The construction of the sentence after translation may be faulty in the sense that it conveys a different meaning than that originally intended in the English draft. It may be faulty also from the point of view of the mode and diction of a given Indian language. While correcting the faults of the second nature the evaluator and the translator must bear in mind that in no case it has to give a different meaning than originally intended in the English draft, especially when such difference in meaning has its impact on the mathematical content of the item.

Col. 5—Many of the items in this test involve real life situations. There might be a reference to mangoes or post-office, some industry, etc., etc. An attempt has been made to select only those real life situations which are common all over India. The evaluator may look into this aspect very carefully. If he feels that the item could not be solved by students in his region because of the unfamiliarity with such situations he should point out this fact. In some case he might be able to suggest a better situation which could be used all over India. In some other cases, he might suggest a situation which may not be familiar to the students in his region. If such a situation can be introduced in the regional version without affecting in any way the mathematical content and operations involved in the item such a change may be made at the discretion of the co-ordinator. All such changes should be separately noted and communicated by the Co-ordinator to the Principal Investigator of the Survey.

Col. 6—The evaluator may suggest a change in the wording of the whole paragraph of the item. The only care that must be taken here is that such change reduces only the non-mathematical complexity or verbal difficulty of the item, but does not in any way change the mathematical content or operations involved in the item.

Col. 7—Here the evaluator may comment regarding the mathematical content of an item. These comments may refer to any of the following dimensions: whether the correct answer is wrong, whether there is more than one correct answer in the item, whether the question asked in the item is mathematically wrong or any other comment that refers to the subject matter in the item.

Col. 8—Any other comments.

APPENDIX 5.2a

FORM FOR EVALUATION

Item No.	Substitute for words	Add these words in brackets	Change in construction of sentence	A more appropriate situation	The non-mathematical complexity of the item could be reduced in the following manner	Comment regarding math. content	Other comments

APPENDIX 5.3

INSTRUCTIONS TO INVIGILATORS AND SUPERVISORS—TRY-OUT STAGE

The Present Phase—Try-out Study

This try-out study is being conducted to see how the items are working. To be more specific we want to have the following information about each question:

(i) What is its difficulty value i.e. how many students can solve this question correctly?

(ii) Whether this question can differentiate between a bright and a weak student?

(iii) Can the students understand the language used in the test?

At this phase we are *not* surveying the achievement in Mathematics. This study is being conducted mainly to improve our tests in the light of the performance of the students and the suggestions given by teachers.

Procedure of Test Administration

(i) *Directions and Sample Items:* The questions used in these tests are of multiple choice type. In order to make the students familiar with these types of questions and the way of marking answers, a small 12-page booklet entitiled 'Directions and Questions for Practice' has been developed. This contains 6 solved questions, explaining how the answers are to be arrived at and marked. Questions 7-12 are for practice by students.

After distributing these booklets to the students, invigilators should read the directions and solve questions 1-6 along with the students. In case the students have some difficulty in understanding the directions or solving the questions 1-6, it may be explained fully. The way of marking the answer should be impressed upon the students and students should be specifically asked to mark the correct answer. It is to be noted that each student will solve questions from 7-12 independently, mark his answers and will then compare his answers with the answers given. In case of discrepancies in answers invigilators will explain how to arrive at the correct answer. Erasing the wrong marks and then marking the correct answer is to be stressed at this stage.

It is suggested that students should use pencils with rubbers to answer questions. All rough work is to be done on the blank space provided at the right hand side of the questions. The students should be asked not to rub off or erase the rough work.

(ii) *Distribution of Test Booklets:* After ensuring that each student has understood how to answer questions in the tests, the teacher will distribute the 'Test Booklet' to each student.

There are 4 forms of each level test. Each student has to work on any one of these. You may thus give the first student of the row Form 1, the second student Form 2, the third student Form 3, the fourth student Form 4 and so on. This is to ensure that they are not able to copy out the answers given by the student sitting next to them. Tell the students that copying is of no use as the questions are different.

(*iii*) *Title Page*: Ask the students to complete the entries on the title page of the Test Booklet. Ensure that everybody has completed them before answering the Test.

(iv) *During Invigilation:* As far as possible Mathematics teachers should be appointed as Invigilators. In case a student finds a word (technical or otherwise) difficult to understand because that is generally not used in that region, the invigilator should give the common regional equivalent. He may consult the English version of the test, if necessary. All such words should be recorded by the Invigilator along with their regional equivalents given to the students.

(v) *Time:* There is no fixed time limit for the tests. Students should be allowed as much time as they require to solve all the items. However when 90% of the students complete the Test the invigilator may ask the remaining ones to stop after waiting for ten or fifteen minutes more.

Our experience in some States shows that 'Directions and Questions for Practice Booklet' takes about one hour for thorough discussion. The Test Booklet takes about 3½ hours for Middle Level Test (75 Questions) and 4½ hours for High School Test (100 Questions.)

The total time could be adjusted in two sessions with a break of 15-20 minutes in-between.

The students may leave their booklets on their seats and come back to them after the interval. In no case should the Test Booklet be taken outside the classroom.

(vi) *Evaluation of Items by Teachers:* To have an idea of the work of questions in the Test, we would also like to know the teachers' opinions about the questions. As such, the attached proforma No. 1 has been devised. Teachers are requested to give their opinions about a question being easy or difficult and reasons that might make a question difficult. The Middle Level Tests are to be examined from the point of view of class IX and the High School Tests from the point of view of XI or I yr. of 3 yrs. B.A. or B.Sc. Course (Classes as in Delhi as at the start of the session.)

This will help us in improving the tests for the final survey.

(vii) *Glossary:* As mentioned in (iv) above, it is necessary to have an idea of the difficulties arising out of non-familiarity with technical terms in regional languages.

The teachers will give the regional equivalents used by them in the class for different technical terms written in the glossary.

Suggestions for improving the tests are most welcome. Plain paper may be used for suggestions not covered in Proforms No. 1 and the glossary.

Duties of the Supervisors:

(i) Fixing the dates and schools for try-out
(ii) Appointing Invigilators teaching Mathematics to the respective classes. (one per section)
(iii) Explaining to the Invigilators their role in the try-out.
(iv) Supplying the necessary material to the schools.
(v) Supervising testing on the spot.
(vi) Getting item-evaluation proformas and glossary filled in.
(vii) Getting the Invigilation receipts and certifying them.
(viii) Seeing to the proper packing of tests and their despatch to Department of Psychological Foundations, New Delhi.

APPENDIX 5.4

GLOSSARY (HIGH SCHOOL)

ARITHMETIC

(A) Simple interest
Compound interest
Rate
Sum
Interest per annum
Rate of interest
Amount

(B) Stock
Below par
Above par
Brokerage
Market value of the stock
Dividend

(C) True discount
Banker's discount
Banker's gain
Discount on a bill
Bill due 4 years hence

(D) Area
Surface area
Volume
Capacity
Unit
Square units
Square metre
Units of area
Cube
Cubical
Edge of a cube
Cubic metre
Rectangle
Rectangular
Diagonal
Square
Height
Base
Perimeter
Cone
Conical form
Slant height
Vertical height
Cylinder/cylindrical
Prism
Sphere
Hemispherical

(E) Discount
Market price
Cost price
Deferred payment
Average
Cube root
Percentage
Positive proper fraction
Decimal fraction
Table of logarithms
Antilog
Number System
Base

ALGEBRA

(A) Negative number
Positive number
For positive values of X and Y
Sum
Product
Quotient
Factor
Fraction

Reciprocal
Algebraic relation
Expression
Function
Identity
Proportional
Inversely proportional
Elimination
Surds
Law
Rule of indices
Constant

(B) Graph
Origin
X-axis
Y-axis
Co-ordinates
X co-ordinate
Y co-ordinates
Intercept
Abscissa
Ordinate
Quadrant
One small square = 1 Unit.

(C) Equation
Simple equation
Linear equation
Quadric equation
Root
Positive root
Real
Imaginary (Line)
Series
Term

GEOMETRY

(A) Angle
Right angle
Acute angle
Obtuse angle
Straight angle
Interior angle
Exterior angle
Alternate angles
Vertical angles
Adjacent angles
Complementary angles
Supplementary angles

(B) Triangle
Triangular
Vertical triangle
Vertex, vertices
Acute-angled triangle
Scalene triangle
Isosceles triangle
Equilateral triangle
Base
Hypotenuse
Right bisector
Perpendicular bisector
Bisector of angle
Median
Altitude
Centroid
Circumcentre
Congruent
Similar
Corresponding sides
Corresponding angles

(C) Polygon
Regular polygon
Quadrilateral
Cyclic quadrilateral
Parallelogram
Trapezium
Isosceles trapezium
Cyclic trapezium
Rhombus
Pentagon
Hexagon
Cotagon
Twelve-sided figure

(D) Circle
Circular
Centre
Diameter
Radius
Chord
Sector
Arc
Segment
Secant
Tangent
Common tangent
Point of contact
Circumference
Semi-circle
Inscribed circle
Circumscribed circle
Concyclic circle
Concentric circle

(E) Sin
Tan
Cos
Cosec.
Sec.
Quadrant
Table of natural sines
Table of natural cosines
Degrees
Mean differences
Angle of elevation
Angle of depression

(F) Statement
Converse
Step
Locus
Collinear
Sets of condition
Parallel
Perpendicular
Transversal
Projection
Line of symmetry

APPENDIX 5.5

INSTRUCTIONS TO FILL IN THE ITEM EVALUATION FORM

Before Filling in The Form

Please write the class in respect of which you are evaluating the particular test and write your name. Please also write the address of the school on the first sheet only.

1. Column 1: write the serial number of the question being evaluated.

2. Column 2: Write E if the question is easy and D if the question is difficult. By easy we mean that 80% of the students in the particular class can get that question correctly. By difficult we mean that 80% of the students of that class *cannot* get the question correctly. Columns 3-9 are to be filled only when a question is difficult. These refer to different reasons for which the question may be regarded difficult.

3. Check col. 3 if you think that the question is from a topic which is not included in the syllabus for that class.

4. Check col. 4 if the topic is in the syllabus for that class but has not been taught by this time.

5. Check col. 5 if the topic is in the syllabus but it has been taught only casually and not intensively.

6. Check col. 6 if the topic is taught but is a difficult one for the students to comprehend.

7. Check col. 7 if you feel that the topical content involved is not difficult but the language of the question is such that the students cannot comprehend the question.

8. Many of the questions in these tests are based on real life situations. It is quite possible that your students may not be familiar with a life situation presented in a particular question. In such a case, please check col. 8.

9. In col. 9 please write any concrete suggestions which may help towards the improvement of the question.

10. In col. 10 you give any other comments about the question not covered in the earlier columns.

APPENDIX 7.1

NOTE FOR THE SUPERVISORS AND TEACHERS IN PRIMARY AND MIDDLE LEVELS

About The Project : The National Council of Educational Research and Training is working on a major project "Mathematics Achievement Survey". The project envisages (I) constructing sequential objective type tests for the three levels of school education *viz.*, the Primary, the Middle and the High School level and (II) surveying the achievements of a sample of schools from all over India. The results of the Survey will help in revising our curriculum, improving our textbooks and in general re-orienting our mathematics education. The first phase of the project has been completed and the tests developed are in your hands for conducting the second phase.

The Second Phase : This involves (a) selecting a sample of schools that is considered representative of schools in different states of India. (b) selecting students from requisite classes in different schools selected and (c) administering the tests.

Aspects (a) of this phase has since been completed in consultation with the Education Department of your state.

Your co-operation is needed for successful conduct of the phases (b) and (c) of the survey. You have hence been asked by the Educational authorities in your State to help us in conducting the survey. The reliability of the survey data depends very much on your co-operation. This could best be rendered by following the DIRECTIONS described below:

General Directions For Both The Supervisor And The Class Teachers : (A Supervisor is one who is in over all charge of testing in a school or a group of schools and a Class Teacher is the teacher who is teaching Mathematics in a selected school).

1. *About The Test :* There are two parallel forms of these tests at each level. Primary level tests are marked as P1 and P2 and the Middle level tests are marked M1 and M2. Each of the Primary level tests contains 50 questions and each of the Middle level tests contains 70 questions.

There are two small booklets "Directions and Questions for Practice". One of these is for Primary level tests and the other for Middle level. The Primary level tests are to be taken up by the students who have recently entered sixth class and middle level tests are for students who have recently entered ninth class.

2. *Selection of Students :* From each school 20-60 students at each level are to be taken up. If there are many sections, only one section is to be taken up. If there is no grouping in different sections on the basis of ability, any section at random may be selected. Otherwise, an average section should be selected. All students in the selected section should be given the test. If there are different streams of Mathematics, form one mixed section of about 50 students selecting from different streams in equal proportion.

3. *Directions And Questions For Practice :* These should be discussed with the students before the actual test is given to them.

4. *Time Limits :* The Primary level tests are of 2½ hours duration. The Middle level tests are of 3 hours duration. The time for starting the tests should be noted. This does not include the time for "Directions and Questions For Practice" booklet and the time required for filling the front page of the test e.g., name, etc.

5. Date Of Testing: Students should be informed of the date of testing. They should be asked to bring rubber and pencil to work with.

6. No help by either the supervisor or the teacher should be given during the test. The students may use their scrap paper for rough work if they so desire.

7. Each student has to work only on one form of the test. Thus, a 6th grade student will work on either P1 or P2. Similarly, a 9th grade student will work on either M1 or M2. These should be distributed in the following manner: In 6th class the 1st student in a row may be given Pl, the second student P2, the third student P1, the fourth student P2 and so on. In the 9th class distribute M1 and M2 in a similar manner. No two students sitting side by side should get the same form.

8. All test materials (including blank tests etc.) are to be returned to the NCERT. The material of a school duly packed should be sent preferrably by railway parcel (To pay—The freight to be paid by the NCERT). If such facilities are not available, the package should be sent by unregistered post parcel under postal certificate. The postage in latter case, will be provided by the Supervisor who will receive it from the Council.

9. The test material for a school is sent in separate packages. One of these contains "Directions and Questions for Practice" booklets. This bundle only should be opened first. Packages containing tests should be opened on the day of testing in the presence of the Supervisor.

10. The "Directions and Questions for Practice" booklets are to be given to students by a teacher a day or two prior to the test proper. If this cannot be done discuss the directions booklet with the students on the same day, before the test is administered.

Specific duties of the Supervisor :

(i) To fix the day for testing in consultation with the school authorities.
(ii) To visit the school on the day of testing.
(iii) To make sure that proper students are selected *viz.*, average class VI for Primary level and average class IX for Middle level.
(iv) To make sure that "Directions and Questions for Practice" have been discussed.
(v) To see that no external help is provided to the students during testing.
(vi) To see that title page is correctly filled in by the students before starting the test.
(vii) To see that the time limit is announced to the students.
(viii) To see that the testing is stopped at the due time.
(ix) To see that the test material is properly despatched, along with the invigilator's report. (Copy of invigilation report is enclosed).

Specific duties of a Teacher :

(i) To announce the date of testing to the students.
(ii) To decide about the students who shall be taking the test. (This situation will arise if there is more than one section arranged on the basis of ability).
(iii) To ask the students to bring pencil and rubber on the day of testing.
(iv) Before the test proper is given, to discuss thoroughly the "Directions and Questions for Practice" booklets with the students. Reading aloud the directions with the students may be helpful.
(v) To see that the students have followed the directions and have been able to solve the questions for practice.

APPENDIX 7.1(a)

NOTE AND INSTRUCTIONS FOR THE SUPERVISORS AND TEACHERS— HIGH SCHOOL LEVEL

About the Project : The National Council of Educational Research and Training is working on a major project 'Mathematics Achievement Survey'. The project envisages (i) constructing sequential objective type tests for the three levels of school education *viz.*, the Primary, the Middle, and the High school level and (ii) surveying the achievement of a sample of schools from all over India. The results of the Survey will help in revising our curriculum, improving our text-books and, in general, re-orienting our mathematics education. The first phase of the Project is since completed and the tests developed are in your hands for conducting the second phase.

The Second Phase : This involves (a) selecting a sample of schools that is considered representative of schools in different states of India, (b) selecting students from requisite classes in different schools so selected and (c) administering the tests.

Aspect (a) of this phase has since been completed in consultation with the Education Department of your State. Your co-operation is needed for successful conduct of the phases (b) and (c) of the Survey. You have hence been asked by the Educational Authorities in your State to help us in conducting the Survey. The reliability of the Survey data depends very much on your co-operation. This could best be rendered by following the Directions described below.

GENERAL DIRECTIONS FOR THE SUPERVISOR AND THE CLASS TEACHER

(A Supervisor is one who is in over all charge of testing in a school or a group of schools and a Class Teacher is the teacher who is teaching Mathematics in a school selected for test administration).

The package you have received consists of:—

(A) Test booklets marked H1 and H2.
(B) Answer sheets with student questionnaire.
(C) 'Directions and Questions for Practice' booklets.
(D) Form for an Invigilation Report.

(A) *About the Test:* Booklets marked H1 and H2 are two parallel forms of the High school test. Each form consists of 80 questions.

(B) *Answer Sheet:* To record the answers to questions from the tests a separate answer sheet is provided. It runs into two pages.

Student Questionnaire : attached with the answer sheet is a questionnaire in which students have to give some information about themselves. It also runs into two pages.

(C) '*Directions and Questions for Practice Booklets*': This booklet explains the manner in which questions in the test are to be answered. It also contains thirteen questions for practice.

(D) *Invigilation Report:* Some information about the students who took the test, their section, stream etc., is to be filled in.

Procedure: A day or two prior to the date of testing the mathematics teacher should give the 'Directions & Questions for Practice' booklets to students. He should also give the answer sheet (along with the questionnaire) to each student. He should read the directions with the students and then ask them to solve questions for practice. The answers to questions for practice should be recorded by the students on the answer sheet in the space provided.

After the students solve the questions for practice the teacher should ask them to fill in the *questionnaire attached with the answer sheet.* Students should be helped in filling up this questionnaire, wherever necessary, PLEASE ASK THE STUDENTS TO ANSWER EACH AND EVERY QUESTION.

After this, both the 'Directions & Questions for Practice' booklets and the answer sheets should then be collected by the teacher. This should be kept in safe custody. At the time of testing a student should be given a test booklet and the answer sheet on which he has already worked. The questionnaire is *not to be cut* away from the answer sheets.

If 'Directions & Questions for Practice' alongwith questionnaire can not be discussed a day or two prior to the day of testing, this should be done before the testing. After testing is over, form of the Invigilation Report is to be filled in. Please supply in the space provided the full information and write down the topics which are in syllabus but *Not Covered* so far due to the school closure, etc.,

1. *Time Limits:* The tests are of 3 hours' duration. The time limit for the 'Directions and Questions for Practice' and for the 'Student Questionnaire' attached to the answer sheet is not fixed. It is observed that students usually take 30 to 40 minutes for the same.
2. *Selection of Students:* From each school 20-60 students are to be taken up. If there are many sections, only one section is to be taken up. If there is no grouping in different sections on the basis of ability, any section at random may be selected. Otherwise, an average section should be selected. All students in the selected section should be given the test.
3. *Date of Testing:* Students should be informed of the date of testing. They should be asked to bring rubber and pencil on that day to work with. After receiving the test material an early date is to be

fixed as far as possible so that other schools may also get the material in time.

4. No help by either the Supervisor or the teacher should be given during the test. The students may use their scrap paper for rough work if they so desire. They are *not to write anything* on the test booklets of H1 and H2 as well as on practice booklets.
5. Each student has to work only on one form of the test, either H1 or H2. Care should be taken that no two students sitting together get the same booklet. This should be done by giving H1 to 1st student in the 1st row, H2 to the 2nd, H1 to the 3rd and so on.
6. The package containing 'Directions & Questions for Practice' and Answer Sheets (with questionnaire) should be opened first. The test package should be opened in the presence of the Supervisor.

SPECIFIC DUTIES OF THE SUPERVISOR

(i) To fix the day for testing in consultation with the school authorities.
(ii) To visit the school on the day of testing.
(iii) To make sure that proper students are selected.
(iv) To make sure that 'Directions & Questions for Practice' have been discussed and answers to the questions for practice given on the separate answer sheet.
(v) To see that no *external help* is provided to the student during testing.
(vi) To make sure that the student questionnaire has been filled in by the students completely.
(vii) To ensure that along with the tests students are given the same answer sheet on which they have answered questions for practice.
(viii) To see that the time limit of the test is announced to the students.
(ix) To see that the testing is stopped at the due time.
(x) To see that the answer sheets along with the Invigilation Report are sent to the department by post. The test booklets, including 'Directions and Questions for Practice' booklets (used and unused) should be sent to the department or to the next school as requested by us.

SPECIFIC DUTIES OF A TEACHER

(i) To announce the date of testing to the students.
(ii) To decide about the students who shall be taking the test. (This situation will arise if there is more than one section, arranged on the basis of ability).
(iii) To ask the students to bring pencils and rubbers on the day of testing.

(iv) Before the test proper is given to discuss thoroughly the 'Directions and Questions for Practice' booklets with the students. Reading aloud the directions with the students may be helpful.

(v) To see that the students have followed the directions and have been able to solve the questions for practice and mark their answers on appropriate places in the answer sheet.

(vi) To get the student questionnaire filled in.

(vii) To give the same answer sheet to students on which they have already worked.

(viii) To emphasize that NOTHING IS TO BE WRITTEN IN THE DIRECTIONS AND QUESTIONS FOR PRACTICE BOOKLET AND THE TEST BOOKLET.

APPENDIX 8.1

ITEM STATISTICS OF PAIRED ITEMS (TRY-OUT AND SURVEY)

Level—Primary

Pair No.	*Present and Previous Places of Items*		*Item Statistics*	*MYSORE*			
				Try-out		*Survey*	
	Form 1	*Form* 2		*Form* 1	*Form* 2	*Form* 1	*Form* 2
1	2	3	4	5	6	7	8
1.	1	1	Diff. I	74.6	56.4	64.0	65.0
	1P1	1P3	Disc. I	39	27	35	47
2.	2	2	Diff. I	60.7	76.5	65.1	84.5
	2P1	2P2	Disc. I	39	41	30	45
3.	3	3	Diff. I	44.2	42.3	47.8	61.8
	2P3	2P4	Disc. I	18	27	26	34
4.	4	4	Diff. I	10.1	13.2	45.4	33.1
	16P2	21P1	Disc. I	44	41	25	22
5.	5	5	Diff. I	16.6	15.8	39.3	32.2
	39P4	42P1	Disc. I	30	38	22	34
6.	6	6	Diff. I	27.2	27.8	38.9	45.3
	12P1	13P1	Disc. I	50	59	35	36
7.	7	8	Diff. I	4.4	8.8	42.1	44.7
	27P2	28P2	Disc. I	21	24	48	35
8.	8	9	Diff. I	6.3	4.4	26.9	33.3
	26P2	29P2	Disc. I	30	27	43	40
9.	9	10	Diff. I	30.7	19.6	52.1	33.3
	15P4	24P1	Disc. I.	40	41	25	42
10.	10	11	Diff. I.	48.7	46.8	66.6	69.2
	7P1	8P1	Disc. I.	51	55	34	50
11.	11	12	Diff. I.	8.3	7.6	27.2	20.0
	7P3	16P3	Disc. I.	29	20	41	2
12.	12	13	Diff. I.	8.2	13.4	25.6	32.4
	8P2	6P4	Disc. I.	30	22	30	42
13.	13	14	Diff. I.	8.9	30.3	25.9	43.6
	8P3	10P2	Disc. I.	9	35	30	27
14.	14	15	Diff. I.	3.1	11.3	18.7	22.6
	47P1	28P1	Disc. I.	29	15	25	21

1	2	3	4	5	6	7	8
15.	15	16	Diff. I.	47.4	55.7	72.3	73.1
	5P3	9P3	Disc. I.	45	51	24	45
16.	16	17	Diff. I.	24.0	24.6	28.5	51.5
	4P1	26P1	Disc. I.	35	43	35	32
17.	17	19	Diff. I.		6.9	15.3	19.8
	Ad.	40P2	Disc. I.		22	0	9
18.	18	20	Diff. I.	6.9	7.0	30.2	30.2
	30P2	10P2	Disc. I.	25	28	52	49
19.	19	21	Diff. I.	11.3	8.9	44.3	35.9
	11P2	21P3	Disc. I.	25	27	37	54
20.	20	23	Diff. I.	18.9	5.7	36.5	19.8
	15P2	22P4	Disc. I.	30	35	34	20
21.	21	24	Diff. I.	3.1	30.1	53.9	56.1
	21P2	21P2	Disc. I.	25	25	17	22
22.	22	25	Diff. I.		16.4	30.9	33.7
	Ad.	3P2	Disc. I.		31	42	45
23.	23	27	Diff. I.	5.1	17.9	29.1	34.2
	23P4	8P4	Disc. I.	16	31	49	47
24.	24	28	Diff. I.	17.9		40.2	49.7
	6P3	Ad.	Disc. I.	47		15	31
25.	25	29	Diff. I.	11.3	35.2	35.9	62.4
	29P1	15P3	Disc. I.	40	49	33	35
26.	26	30	Diff. I.	39.1	6.3	66.4	30.0
	37P4	38P2	Disc. I.	46	25	19	33
27.	27	31	Diff. I.	8.2	24.0	42.8	35.7
	50P1	5P2	Disc. I.	25	22	17	28
28.	28	36	Diff. I.	17.0	6.3	44.8	19.3
	6P1	19P2	Disc. I.	47	35	35	29
29.	29	32	Diff. I.	21.5	10.7	41.1	29.8
	17P1	18P1	Disc. I.	36	45	40	39
30.	30	33	Diff. I.	24.0	23.7	36.1	54.3
	20P1	32P3	Disc. I.	61	34	34	44
31.	31	34	Diff. I.	26.9	10.8	51.5	31.1
	27P4	29P3	Disc. I.	53	21	47	26
32.	32	35	Diff. I.	23.7	19.8	39.7	46.4
	28P4	30P3	Disc. I.	59	36	32	45
33.	33	37	Diff. I.	12.6	14.5	19.6	38.4
	18P2	31P1	Disc. I.	30	38	30	45
34.	34	38	Diff. I.	12.1	11.3	33.5	30.7
	36P3	32P2	Disc. I.	24	29	33	31

1	2	3	4	5	6	7	8
35.	35	39	Diff. I.	24.0	9.6	29.3	27.2
	22P1	10P4	Disc. I.	50	20	25	36
36.	36	26	Diff. I.	8.3	9.4	17.2	20.4
	39P3	35P1	Disc. I.	32	40	30	21
37.	37	40	Diff. I.	11.5	11.5	28.9	11.4
	47P4	50P3	Disc. I.	45	31	39	30
38.	38	7	Diff. I.	1.9	5.0	17.9	17.3
	11P4	27P1	Disc. I.	25	16	35	38
39.	39	42	Diff. I.	14.7	11.3	40.4	38.1
	45P4	14P1	Disc. I.	34	45	20	37
40.	40	43	Diff. I.	8.9	12.8	24.3	21.1
	31P3	31P4	Disc. I.	30	15	15	20
41.	41	46	Diff. I.	5.1	3.8	25.6	20.2
	42P4	33P3	Disc. I.	20	25	21	25
42.	42	41	Diff. I.		8.9	12.2	19.5
	50P4	13P3	Disc. I.		36	29	45
43.	43	44	Diff. I.	24.3		55.1	55.6
	44P3	Ad.	Disc. I.	57		43	51
44.	44	45	Diff. I.	5.1		16.3	16.2
	45P3	Ad.	Disc. I.	28		16	22
45.	45	18	Diff. I.	17.0	6.4	40.8	21.3
	23P2	28P3	Disc. I.	37	33	19	32
46.	46	47	Diff. I.	23.7	21.7	55.2	51.7
	44P4	12P4	Disc. I.	41	47	46	40
47.	47	49	Diff. I.	8.8	1.2	35.9	18.2
	40P1	39P1	Disc. I.	40	0	23	17
48.	48	50	Diff. I.	16.4	8.2	36.7	37.5
	33P1	34P1	Disc. I.	45	28	43	33
49.	49	22	Diff. I	8.9	45.5	43.9	83.2
	18P3	19P3	Disc. I.	20	58	25	25
50.	50	48	Diff. I.	11.3	23.0	37.8	31.6
	37P2	42P3	Disc. I.	30	34	35	32

APPENDIX 8.2

ITEMS STATISTICS OF PAIRED ITEMS (TRY-OUT AND SURVEY)

Level—Middle

Pair No.	*Present and Previous Places of Items*		*Item Statistics*	*ORISSA*			
				Try-Out		*Survey*	
	Form 1	*Form* 2		*Form* 1	*Form* 2	*Form* 1	*Form* 2
1	2	3	4	5	6	7	8
1.	1	1	Diff. I.	57.4	53.2	17.4	42.4
	10M1	3M4	Disc. I.	50	45	33	30
2.	2	51	Diff. I.	4.4	20.1	6.5	9.5
	38M4	5M2	Disc. I.	0	40	17	14
3.	3	3	Diff. I.	90.9	82.0	55.0	53.3
	1M2	1M3	Disc. I.	24	30	33	22
4.	4	4	Diff. I.	31.6	38.0	47.6	28.3
	37M4	9M1	Disc. I.	41	29	30	31
5.	5	2	Diff. I.	55.2	55.0	48.5	42.2
	IM1	24M2	Disc. I.	32	36	46	40
6.	6	5	Diff. I.	39.7	20.4	36.5	37.7
	61M4	10M2	Disc. I.	36	32	44	30
7.	7	6	Diff. I.	8.6	11.9	5.6	5.0
	55M4	52M4	Disc. I.	20	21	15	25
8.	8	7	Diff. I.	33.4	38.1	16.1	24.1
	51M4	37M2	Disc. I.	21	37	25	18
9.	9	9	Diff. I.	26.9	47.3	20.1	23.9
	17M1	23M1	Disc. I.	30	49	19	37
10.	10	8	Diff. I.	27.1	55.8	31.4	42.4
	9M3	2M1	Disc. I.	29	36	27	35
11.	11	14	Diff. I.	36.4		18.0	21.3
	25M2	Ad.	Disc. I.	45		25	36
12.	12	11	Diff. I.	58.2	67.3	38.9	53.3
	16M3	12M2	Disc. I.	40	45	22	38
13.	13	10	Diff. I.	35.2	44.6	25.8	19.8
	46M3	9M2	Disc. I.	50	42	32	33
14.	14	13	Diff. I.	54.6	33.0	53.8	31.1
	18M1	37M1	Disc. I.	31	22	16	31

1	2	3	4	5	6	7	8
15.	15	12	Diff. I.	37.7	34.6	30.9	18.9
	42M3	74M4	Disc. I.	27	48	26	31
16.	16	15	Diff. I.	47.5	64.1	24.7	61.2
	8M2	36M2	Disc. I.	47	42	45	31
17.	17	16	Diff. I.	23.8	31.5	22.1	20.0
	33M4	24M1	Disc. I.	41	36	18	32
18.	18	17	Diff. I.	12.2	17.6	4.5	10.8
	62M4	47M3	Disc. I.	20	23	10	10
19.	19	19	Diff. I.	55.8	51.0	43.8	44.4
	21M1	35M2	Disc. I.	47	40	46	23
20.	20	22	Diff. I.	20.8	27.7	17.2	25.7
	45M4	31M3	Disc. I.	34	34	20	24
21.	21	23	Diff. I.	4.7	6.8	2.1	4.7
	21M3	22M3	Disc. I.	25	30	0	5
22.	22	18	Diff. I.	44.00	53.0	35.8	30.0
	52M2	56M2	Disc. I.	38	42	13	21
23.	23	20	Diff. I.	22.9	21.9	30.0	12.2
	75M4	13M1	Disc. I.	7	46	8	11
24.	24	25	Diff. I.	35.8	48.4	30.3	35.9
	55M3	57M4	Disc. I.	55	31	40	36
25.	25	24	Diff. I.	23.8	48.6	16.9	31.1
	63M4	21M2	Disc. I.	28	27	25	27
26.	26	26	Diff. I.	35.2	30.4	24.3	18.3
	13M2	14M1	Disc. I.	30	28	27	19
27.	27	28	Diff. I.	8.9	20.7	16.3	40.3
	64M4	31M1	Disc. I.	13	39	30	22
28.	28	27	Diff. I.	9.8	26.9	16.7	28.9
	65M4	29M1	Disc. I.	28	35	40	30
29.	29	29	Diff. I.	7.7	20.5	10.7	11.9
	66M4	23M3	Disc. I.	23	30	32	21
30.	30	70	Diff. I.	47.3	18.8	18.9	16.9
	39M1	43M4	Disc. I.	50	29	35	27
31.	31	34	Diff. I.	45.4	31.9	34.9	45.0
	75M2	72M3	Disc. I.	60	47	27	32
32.	32	21	Diff. I.	23.0	13.1	19.0	14.1
	14M2	69M4	Disc. I.	32	38	33	20
33.	33	31	Diff. I.	63.2	45.0	35.0	42.4
	3M4	43M3	Disc. I.	37	27	18	39
34.	34	30	Diff. I.	27.4		17.2	28.1
	20M1	Ad.	Disc. I.	34		24	31

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1	2	3	4	5	6	7	8
35.	35	32	Diff. I.	14.6	53.2	50.5	21.1
	36M2	49M1	Disc. I.	25	41	34	35
36.	36	33	Diff. I.	68.2	57.0	46.0	44.0
	61M2	65M2	Disc. I.	9	56	25	33
37.	37	35	Diff. I.	81.1	79.8	40.7	59.6
	12M4	45M1	Disc. I.	40	35	45	25
38.	38	36	Diff. I.	62.3	57.6	34.7	34.2
	8M4	64M2	Disc. I.	51	70	32	33
39.	39	37	Diff. I.	18.8	45.3	14.3	19.1
	54M4	23M3	Disc. I.	15	62	25	35
40.	40	38	Diff. I.	56.4	36.2	32.3	19.6
	7M4	47M1	Disc. I.	40	26	27	12
41.	41	39	Diff. I.	48.5		23.0	24.1
	56M1	Ad.	Disc. I.	29		22	—7
42.	42	41	Diff. I.	65.3	18.3	37.4	11.5
	59M2	58M2	Disc. I.	50	20	53	20
43.	43	40	Diff. I.	33.1	44.7	24.9	22.8
	25M2	13M2	Disc. I.	32	39	5	42
44.	44	42	Diff. I.	38.8	49.4	20.1	22.8
	10M3	57M1	Disc. I.	55	48	21	35
45.	45	43	Diff. I.	52.0		26.5	34.4
	51M1	Ad.	Disc. I.	37		35	22
46.	46	44	Diff. I.	52.2	37.6	24.0	22.4
	46M4	14M4	Disc. I.	45	54	50	32
47.	47	45	Diff. I.	56.7	43.5	33.8	30.9
	2M4	40M4	Disc. I.	46	31	37	34
48.	48	46	Diff. I.	19.2	29.1	10.1	10.6
	59M1	69M2	Disc. I.	34	37	17	30
49.	49	47	Diff. I.	5.3	17.7	11.4	9.5
	64M3	71M2	Disc. I.	21	21	19	32
50.	50	48	Diff. I.	4.4	27.6	8.0	40.7
	65M3	72M2	Disc. I.	—10	34	16	20
51.	51	49	Diff. I.	26.3	36.1	22.1	26.3
	55M1	6M3	Disc. I.	48	54	40	42
52.	52	50	Diff. I.	14.0	22.0	8.1	6.1
	17M4	10M4	Disc. I.	25	45	36	21
53.	53	53	Diff. I.	77.5	33.4	36.1	23.5
	42M2	44M3	Disc. I.	40	40	17	22
54.	54	52	Diff. I.	85.6	40.2	71.2	35.0
	8M3	24M4	Disc. I.	20	25	35	33

1	2	3	4	5	6	7	8
55.	55 67M1	55 11M3	Diff. I. Disc. I.	72.8 40	80.5 25	54.5 27	45.5 35
56.	56 70M1	57 62M1	Diff. I. Disc. I.	42.1 30	76.9 50	32.1 31	54.9 36
57.	57 41M2	54 21M4	Diff. I. Disc. I.	55.3 36	73.9 44	38.0 23	53.1 55
58.	58 66M3	56 61M1	Diff. I. Disc. I.	51.6 46	63.1 35	37.8 32	44.0 40
59.	59 71M1	63 29M2	Diff. I. Disc. I.	35.0 45	18.3 33	12.1 20	16.1 40
60.	60 28M4	62 40M3	Diff. I. Disc. I.	36.7 36	23.5 46	29.0 26	16.9 21
61.	61 35M4	60 25M4	Diff. I. Disc. I.	48.0 36	22.0 45	32.2 25	14.8 23
62.	62 67M3	58 47M4	Diff. I. Disc. I.	46.5 55	39.7 13	31.2 27	19.8 20
63.	63 49M4	61 34M4	Diff. I. Disc. I.	55.1 39	57.0 38	36.3 32	45.9 32
64.	64 22M4	59 23M4	Diff. I. Disc. I.	41.1 48	53.7 30	25.6 32	49.2 30
65.	65 57M3	64 29M3	Diff. I. Disc. I.	44.1 41	37.9 31	38.1 28	36.1 25
66.	66 22M1	68 40M1	Diff. I. Disc. I.	80.7 55	31.5 30	48.0 57	15.4 35
67.	67 16M4	67 18M4	Diff. I. Disc. I.	65.9 42	36.1 42	32.0 17	20.6 23
68.	68 66M1	65 63M1	Diff. I. Disc. I.	60.8 38	59.9 34	39.4 32	42.0 31
69.	69 14M3	69 33M2	Diff. I. Disc. I.	26.2 45	41.3 35	15.4 30	21.1 43
70.	70 20M3	66 43M4	Diff. I. Disc. I	31.0 39	18.8 29	13.0 30	27.4 26

APPENDIX 8.3

ITEMS STATISTICS OF PAIRED ITEMS (TRY-OUT AND SURVEY)

Level—High

Pair No.	*Present and Previous Places of Items*		*Items Statistics*	*Public School*			
				Try-out		*Survey*	
	Form 1	*Form* 2		*Form* 1	*Form* 2	*Form* 1	*Form* 2
1	2	3	4	5	6	7	8
1.	1	2	Diff. I.	72	35.0	82.9	48.0
	17H2	51H4	Disc. I	33	23	46	6
2.	2	1	Diff. I.	35.2	25.3	67.0	53.2
	37H2	53H3	Disc. I	40	35	31	35
3.	3	6	Diff. I	31.3	11.3	67.9	19.4
	53H4	52H3	Disc. I.	32	29	40	47
4.	4	5	Diff. I.	14.1	29.7	43.9	71.4
	86H1	35H2	Disc. I.	19	27	53	65
5.	5	7	Diff. I.	27.6	30.6	29.2	36.3
	58H3	57H3	Disc. I	31	28	15	6
6.	6	8	Diff. I.	7.6	5.6	26.8	38.9
	8H1	3H3	Disc. I.	7	—2	20	35
7.	7	11	Diff. I	5.0	6.5	6.0	6.4
	7H1	15H1	Disc. I.	—9	11	8	27
8.	8	10	Diff. I	16.1	16.1	15.8	10.3
	46H2	46H2	Disc. I.	0	0	28	22
9.	9	9	Diff. I.	25.3	41.6	65.8	61.0
	55H4	9H1	Disc. I.	30	18	40	42
10.	10	12	Diff. I.	21.6	10.9	28.0	2.5
	39H2	3H1	Disc. I.	22	20	15	27
11.	11	23	Diff. I.	18.9	38.6	79.2	41.5
	4H3	60H3	Disc. I.	18	37	14	40
12.	12	25	Diff. I.	50.7	58.9	45.1	77.9
	15H4	18H4	Disc. I.	24	40	42	50
13.	13	14	Diff. I.	14.1	9.8	31.1	29.8
	46 H4	55 H3	Disc. I.	22	17	17	22
14.	14	15	Diff. I.	7.8	12.5	42.6	62.3
	63 H4	85 H3	Disc. I.	22	28	37	25

1	2	3	4	5	6	7	8
15.	15	19	Diff. I.	6.6	7.9	18.2	18.1
	49 H2	72 H3	Disc. I	27	12	40	25
16.	16	17	Diff. I.	5.2	9.4	30.4	24.6
	41 H4	98 H3	Disc. I.	28	20	—8	9
17.	17	16	Diff. I.	54.5	16.9	79.2	55.8
	21 H3	51 H2	Disc. I.	55	27	34	44
18.	18	13	Diff. I.	6.9	6.9	9.1	18.1
	19 H2	12 H1	Disc. I.	19	20	21	0
19.	19	20	Diff. I.	19.8	24.3	59.7	63.6
	36 H2	14 H1	Disc. I.	31	22	68	49
20.	20	26	Diff. I.	20.5	32.3	35.3	35.0
	69 H2	53 H1	Disc. I.	32	42	37	23
21.	21	28	Diff. I.	18.9	50.7	25.6	58.4
	59 H3	68 H2	Disc. I.	24	34	34	6
22.	22	29	Diff. I.	48.8	33.8	47.5	49.3
	20 H4	66 H2	Disc. I.	39	44	28	35
23.	23	32	Diff. I.	25.8	53.8	30.4	49.3
	58 H1	51 H1	Disc. I.	29	35	7	40
24.	24	30	Diff. I.	14.7	16.3	18.2	35.0
	72 H2	60 H1	Disc. I.	30	22	31	38
25.	25	31	Diff. I.	32.3	23.8	42.6	38.9
	73 H2	74 H2	Disc. I.	40	23	19	20
26.	26	35	Diff. I.	13.2	45.0	31.7	53.2
	88 H2	54 H1	Disc. I.	27	36	42	40
27.	27	27	Diff. I.	10.6	16.4	23.1	41.5
	26 H3	21 H4	Disc. I.	20	20	28	23
28.	28	36	Diff. I.	14.9	19.4	37.8	46.7
	69 H1	78 H2	Disc. I.	24	31	47	38
29.	29	33	Diff. I.	16.3	16.0	34.1	24.6
	61 H1	72 H1	Disc. I.	40	30	56	43
30.	30	42	Diff. I.	53.3	16.9	59.7	25.9
	30 H4	94 H2	Disc. I.	40	33	55	9
31.	31	43	Diff. I.	19.6	21.2	30.4	27.2
	88 H3	39 H4	Disc. I.	29	24	34	35
32.	32	32	Diff. I.	29.9	29.8	39.3	35.0
	22 H3	8 H4	Disc. I.	32	36	27	23
33.	33	37	Diff. I.	12.8	12.8	29.2	24.6
	95 H2	95 H2	Disc. I.	20	20	22	8
34.	34	40	Diff. I.	8.8	37.5	36.5	68.
	87 H2	61 H3	Disc. I.	12	37	48	45

1	2	3	4	5	6	7	8
35.	35	39	Diff. I.	57.0	17.9	71.9	29.8
	13 H4	12 H4	Disc. I.	35	32	51	28
36.	36	45	Diff. I.	15	14.1	29.2	18.1
	82 H2	80 H1	Disc. I.	27	31	19	0
37.	37	41	Diff. I.	72.0	16.2	82.9	42.8
	42 H4	100 H3	Disc. I.	30	33	50	12
38.	38	4	Diff. I.	14.7	6.4	28.0	41.5
	46 H3	90 H3	Disc. I.	38	47	40	34
39.	39	44	Diff. I.	15.6	19.8	34.1	22.0
	76 H1	100 H2	Disc. I.	37	35	24	20
40.	40	46	Diff. I.	18.3	14.5	41.4	19.4
	63 H2	32 H4	Disc. I.	30	26	6	—20
41.	41	3	Diff. I.	29.2	12.6	34.1	37.6
	68 H1	24 H4	Disc. I.	45	9	24	31
42.	42	48	Diff. I.	35.4	48.8	71.9	67.5
	31 H4	98 H2	Disc. I.	26	38	42	45
43.	43	47	Diff. I.	15.8	31.9	45.1	25.9
	47 H2	96 H2	Disc. I.	31	34	17	57
44.	44	49	Diff. I.	44.7	40.2	62.1	70.1
	33 H4	26 H4	Disc. I.	31	35	34	28
45.	45	52	Diff. I.	12.3	9.4	20.0	41.5
	66 H4	92 H3	Disc. I.	26	22	55	23
46.	46	50	Diff. I.	47.6	67.2	51.2	84.4
	21 H1	1 H2	Disc. I.	35	35	70	50
47.	47	22	Diff. I.	23.6	14.1	13.4	22.0
	19 H1	20 H1	Disc. I.	34	33	20	52
48.	48	24	Diff. I.	22.7	18.1	56.0	66.2
	29 H3	30 H3	Disc. I.	32	35	23	15
49.	49	21	Diff. I.	22.3	7.4	41.4	25.9
	37 H3	34 H4	Disc. I	39	35	47	22
50.	50	53	Diff. I.	44.8	45.4	48.7	66.2
	5 H2	23 H1	Disc. I.	28	29	50	34
51.	51	51	Diff. I.	16.1	33.4	25.6	59.7
	8 H2	3 H2	Disc. I.	29	17	37	35
52.	52	55	Diff. I.	8.3	32.7	29.2	58.4
	67 H3	35 H1	Disc. I.	16	21	20	32
53.	53	56	Diff. I.	30.2	30.2	52.4	62.3
	65 H4	69 H4	Disc. I.	22	19	29	45
54.	54	62	Diff. I.	12.6	8.3	31.7	55.8
	79 H4	46 H1	Disc. I.	20	28	35	41

1	2	3	4	5	6	7	8
55.	55	54	Diff. I.	33.0	5.8	46.3	29.8
	33 H1	41 H1	Disc. I.	10	27	6	13
56.	56	57	Diff. I.	13.4	44.8	28.0	44.1
	84 H4	18 H2	Disc. I.	20	27	16	14
57.	57	58	Diff. I.	22.7	22.7	40.2	32.4
	12 H2	12 H2	Disc. I.	18	18	17	10
58.	58	59	Diff. I.	7.3	15.1	19.5	59.7
	7 H2	69 H3	Disc. I.	20	24	25	41
59.	59	60	Diff. I.	22	8.3	34.1	19.4
	4 H2	22 H1	Disc. I.	27	20	42	47
60.	60	61	Diff. I.	26.8	45.8	56.0	51.9
	2 H2	35 H4	Disc. I.	26	22	53	40
61.	61	34	Diff. I.	10.6	2.6	14.6	10.3
	8 H3	7 H3	Disc. I.	19	20	25	19
62.	62	64	Diff. I.	12.1	12.1	14.6	20.7
	23 H2	81 H3	Disc. I.	21	22	29	8
63.	63	65	Diff. I.	29.7	11.9	64.6	18.1
	25 H2	72 H4	Disc. I.	48	10	34	20
64.	64	63	Diff. I.	19.8	20.5	21.9	45.4
	27 H2	24 H2	Disc. I.	10	40	25	12
65.	65	66	Diff. I.	8	5.8	32.9	20.7
	61 H2	31 H1	Disc. I.	12	20	23	23
66.	66	68	Diff. I.	24.6	29.8	51.2	41.5
	10 H2	49 H1	Disc. I.	21	22	37	23
67.	67	69	Diff. I.	10.0	23.4	21.9	67.5
	78 H4	11 H3	Disc. I.	23	29	20	38
68.	68	70	Diff. I.	65.0		58.5	55.8
	42 H1	1 Ad.	Disc. I.	38		58	52
69.	69	67	Diff. I.	62.8	60.3	47.5	40.2
	44 H3	43 H1	Disc. I.	24	37	37	51
70.	70	71	Diff. I.	26.8	4.0	60.9	14.2
	91 H4	50 H1	Disc. I.	37	19	75	6
71.	71	72	Diff. I.	14.5	14.7	19.5	23.3
	85 H1	47 H3	Disc. I.	30	40	25	0
72.	72	74	Diff. I.	9.1	10.9	13.4	18.1
	65 H2	89 H1	Disc. I.	35	16	30	40
73.	73	73	Diff. I.	29.8	34.9	52.4	57.1
	29 H1	88 H1	Disc. I.	36	29	53	40
74.	72	80	Diff. I.	12.8	13.6	43.9	33.7
	42 H2	95 H3	Disc. I.	14	11	8	62

1	2	3	4	5	6	7	8
75.	75	75	Diff. I.	14.0	14.3	26.8	19.4
	83 H6	52 H2	Disc. I.	19	21	30	32
76.	76	76	Diff. I.	12.8	8.8	25.6	18.1
	97 H3	53 H2	Disc. I.	19	5	34	0
77.	77	18	Diff. I.	31.3	26.9	24.3	61.0
	36 H4	91 H1	Disc. I.	48	46	47	46
78.	78	77	Diff. I.	39.5	13.0	46.3	33.7
	17 H4	92 H1	Disc. I.	30	14	50	25
79.	79	79	Diff. I.	17.9	19.8	26.8	32.4
	48 H4	77 H2	Disc. I.	10	31	22	25
80.	80	78	Diff. I.	3.7	13.6	10.9	28.5
	15 H3	95 H3	Disc. I.	4	11	19	29

N.B. : Ad. refers to additional item.

APPENDIX 8.4

KEY FOR PI FINAL

No.	*Answer*	*Q. No.*	*Answer*
1.	C	26.	B
2.	B	27.	B
3.	C	28.	C
4.	D	29.	D
5.	A	30.	C
6.	D	31.	D
7.	C	32.	C
8.	C	33.	A
9.	A	34.	B
10.	B	35.	A
11.	B	36.	A
12.	C	37.	B
13.	C	38.	C
14.	B	39.	D
15.	C	40.	C
16.	A	41.	D
17.	B	42.	B
18.	B	43.	D
19.	D	44.	C
20.	B	45.	A
21.	B	46.	A
22.	D	47.	B
23.	D	48.	A
24.	D	49.	D
25.	C	50.	C

KEY FOR P II FINAL

1.	A	9.	B
2.	C	10.	B
3.	D	11.	C
4.	B	12.	D
5.	D	13.	C
6.	A	14.	D
7.	B	15.	C
8.	C	16.	D

APPENDIX 8.4 (*contd.*)

Q. No.	*Answer*	*Q. No.*	*Answer*
17.	B	34.	A
18.	B	35.	B
19.	D	36.	B
20.	A	37.	B
21.	B	38.	B
22.	D	39.	C
23.	C	40.	B
24.	B	41.	A
25.	D	42.	C
26.	C	43.	C
27.	C	44.	B
28.	B	45.	D
29.	A	46.	D
30.	C	47.	C
31.	A	48.	B
32.	C	49.	A
33.	D	50.	B

APPENDIX 8.5

KEY FOR M1 FINAL

Q. No.	*Answer*	*Q. No.*	*Answer*
1.	B	36.	D
2.	C	37.	C
3.	A	38.	D
4.	C	39.	C
5.	A	40.	D
6.	B	41.	C
7.	A	42.	B
8.	D	43.	D
9.	C	44.	A
10.	A	45.	A
11.	B	46.	A
12.	B	47.	D
13.	D	48.	B
14.	A	49.	B
15.	B	50.	A
16.	A	51.	C
17.	A	52.	B
18.	A	53.	D
19.	A	54.	A
20.	B	55.	D
	A	56.	A
22. 27.	C	57.	B
23.	D	58.	D
24.	B	59.	B
25.	C	60.	B
26.	C	61.	B
27.	C	62.	B
28.	B	63.	C
29.	B	64.	B
30.	B	65.	B
31.	D	66.	B
32.	B	67.	C
33.	B	68.	B
34.	B	69.	B
35.	A	70.	B

APPENDIX 8.5 (*contd.*)

KEY FOR M2 FINAL

Q. No.	*Answer*	*Q. No.*	*Answer*
1.	B	36.	A
2.	B	37.	A
3.	B	38.	C
4.	C	39.	D
5.	A	40.	B
6.	B	41.	A
7.	A	42.	A
8.	A	43.	C
9.	B	44.	A
10.	C	45.	B
11.	C	46.	C
12.	A	47.	B
13.	A	48.	D
14.	B	49.	C
15.	B	50.	A
16.	A	51.	B
17.	B	52.	D
18.	A	53.	D
19.	D	54.	B
20.	D	55.	B
21.	A	56.	B
22.	C	57.	B
23.	C	58.	C
24.	C	59.	D
25.	B	60.	A
26.	D	61.	D
27.	A	62.	A
28.	D	63.	B
29.	A	64.	D
30.	B	65.	B
31.	B	66.	C
32.	C	67.	D
33.	C	68.	A
34.	C	69.	C
35.	D	70.	A

APPENDIX 8.6

KEY FOR HI Final

Q. No.	*Answer*	*Q. No.*	*Answer*
1.	B	41.	B
2.	A	42.	B
3.	D	43.	D
4.	B	44.	D
5.	C	45.	B
6.	B	46.	A
7.	C	47.	B
8.	C	48.	C
9.	B	49.	A
10.	A	50.	A
11.	A	51.	A
12.	C	52.	D
13.	B	53.	B
14.	D	54.	A
15.	C	55.	D
16.	A	56.	C
17.	B	57.	A
18.	B	58.	A
19.	B	59.	C
20.	D	60.	C
21.	D	61.	D
22.	B	62.	D
23.	D	63.	B
24.	A	64.	D
25.	C	65.	B
26.	C	66.	D
27.	C	67.	C
28.	A	68.	D
29.	B	69.	B
30.	A	70.	C
31.	B	71.	B
32.	D	72.	C
33.	D	73.	B
34.	C	74.	B
35.	A	75.	C
36.	B	76.	B
37.	C	77.	A
38.	A	78.	C
39.	D	79.	A
40.	A	80.	C

APPENDIX 8.6 (*contd.*)

KEY FOR H2 FINAL

Q. No.	*Answer*	*Q. No.*	*Answer*
1.	A	41.	B
2.	D	42.	A
3.	D	43.	A
4.	C	44.	C
5.	C	45.	A
6.	A	46.	B
7.	B	47.	C
8.	B	48.	C
9.	D	49.	B
10.	C	50.	B
11.	A	51.	D
12.	A	52.	D
13.	C	53.	D
14.	A	54.	A
15.	D	55.	B
16.	A	56.	C
17.	C	57.	C
18.	D	58.	A
19.	B	59.	B
20.	C	60.	B
21.	D	61.	B
22.	A	62.	C
23.	B	63.	B
24.	A	64.	A
25.	B	65.	C
26.	A	66.	D
27.	B	67.	D
28.	D	68.	A
29.	D	69.	B
30.	A	70.	B
31.	C	71.	A
32.	A	72.	C
33.	C	73.	A
34.	A	74.	D
35.	D	75.	C
36.	D	76.	B
37.	A	77.	C
38.	A	78.	D
39.	C	79.	A
40.	A	80.	B

APPENDIX 12.1

CATEGORISATION OF OCCUPATIONS

1. **Professional and Technical**
   - A. Doctors, Engineers, Scientists, Judges, Architects, Artists, Lawyers, Advocates, etc.
   - B. Nurses, Compounders, Writers, Journalists, Surveyors, Physicians etc.
   - C. Laboratory Attendants, Fieldsmen, etc.
2. **Administrative, Executive, Managerial, Clerical**
   - A. Administrators, Directors, Collectors, IAS Officers etc.
   - B. (Excise) Inspectors, IAC Officers, Sales Tax Officers, Post Masters, Station Masters, etc.
   - C. Clerks, Typists, Munshi, Steno-typists, etc.
3. **Business**
   - A. Proprietors, Bankers, Businessmen, etc.
   - B. Contractors, Managers, etc.
   - C. Salesmen, Shop Assistants, Transport Agents, etc.
4. **Farmers, Fishermen, etc.**
   - A. Zamindars, etc.
   - B. Dairy owners, Farmers, etc.
   - C. Fishermen, Milkmen, Agricultural Workers, etc.
5. **Skilled Workers**
   - B. Guard, Foreman, Goldsmith, Wireless Operator, Driver, Weaver, Supervisor etc.
   - C. Fitter, Leather Cutter, Mason, Pointsman, Barber, Carpenters etc.
6. **Unskilled Workers**
   - B. Supervisor
   - C. Labourers, Domestic Servants
7. **Defence Services & Police**
   - A. Army Officer, Police Officer, Commander, Major, Pilot Officer, etc.
   - B. Inspector of Police, Lieutanant, etc.
   - C. Sepoy, Police Constable etc.

8. **Teaching Profession**
   - A. Heads of Departments, Professors, Readers, Principals of Colleges etc.
   - B. Lecturers, Heads of Schools, Teachers, etc.

9. **Social Services**
   - A. Ministers, M.P., M.L.A.. etc.
   - B. Jilla Parishad & Panchayat President; Councillor, Social Worker, Volunteer etc.
   - C. Villageman

N.B.:—Subcategories A, B and C refer to High, Middle and Low levels of occupations respectively.

APPENDIX 13.1

CARD DESIGN—PRIMARY LEVEL

Column (s)	*Description*
1	Project No.
2	Regn. No./level
3	Form
4-5	Language
6-7	State
8	Region
9	Sector
10	Management
11-13	School
14-15	Student
16-17	Age
18	Age at which first admitted
19	Class to which first admitted
20	Nursery schooling
21	Age at which Nursery schooling started
22	Class of study
23	Sex
24-73	Items (1-50) of MAS Test (one column for each item)

APPENDIX 13.2

CARD DESIGN—MIDDLE LEVEL

Column (s)	*Description*
1	Form
2-4	School
5-6	Student
7	Age
8	Age at which the student was first admitted
9	Class to which first admitted/age
10	Opting for Hr. Math./Stream
11-80	Items (1-70) of MAS test (one column for each item)

APPENDIX 13.3

CARD DESIGN—HIGH SCHOOL LEVEL

1st Card

Column(s)	*Description*
1	Project (006)
2	Regn. No. (3)
3	Form
4-5	Language
6-7	State
8	Region
9	Sector
10	Management
11-13	School
14-15	Student
16-75	Items (1-60) of the MAS test (one col. for each item)

2nd Card

1-15	Identification as in 1st card except in Col. 2 (Punch 4)
16-35	Items (61-80) of the MAS test (one col. for each item)
	Questionnaire as follows:
36-42	Questions 1-7: As answered
43-45	Question 8: In 3 cols; as coded
46-51	Question 9-14: As answered
52-53	Question 15: As coded
54	Question 16: As answered
55-58	Question 17 as follows: If No, then in all cols. = 2 If Yes, then in col. 55 = 1 in col. 56 = 1 or 2 (According as the in col. 57 = 1 or 2 (answer is 'Yes' or in col. 58 = 1 or 2 ('No' for 17 (a), (b), (c)
59-73	Question 18-32: As answered
74-78	Question 33 (a)—33(e): As answered

NOTE: 1. For all questions with 'Yes' or 'No' answers, punch 1 for 'Yes' and 2 for 'No'.

2. If any question in unanswered, punch O.

3. Question 17: If Q. 17 has answer No, answer to Q. 17(a), 17(b), 17(c) should be treated as 'No'.

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